

Andreas Iseus Hatziliou

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EDUCATION

- **University of British Columbia** Vancouver, BC
Master of Science in Mathematics | GPA 4.0/4.0 *Sept 2021 - May 2023*
- **McGill University** Montreal, QC
Bachelor of Science in Mathematics (Honours) and Computer Science (Minor) | GPA 3.64/4.0 *Sept 2018 - May 2021*
Distinction: First Class Honours in Mathematics

EXPERIENCE

- **Graduate Research Assistant** *Sept 2021 - May 2023*
University of British Columbia
 - Finding elliptic curves of high rank and predicting quantities such as rank and order of Sha using machine learning models.
 - Generalized results from my previous paper to coefficients of form $\pm q^\alpha$ for $3 < q < 100$ prime using methods of Bennett et al.
- **Teaching Assistant** *Sept 2021 - May 2023*
University of British Columbia
 - Organizing and hosting office hours. Writing questions and solutions to assignments. Grading exams.
 - Head TA for the Mathematics Learning Centre (MLC)
McGill University *Fall 2020*
 - Responsible for marking and entering grades of the weekly assignments in Honours Complex Analysis using the Crowdmark platform.
- **Private Tutor** *Jan 2018 - Present*
 - Tutored CEGEP and university students in courses such as Differential, Integral and Multivariable Calculus, ODEs, Mechanics and Electricity and Magnetism.
 - Prepared sessions tailored to each individual student's needs, which covered in-class material and supplemented it with exercises and examples to reinforce their understanding and improve on their weaknesses.

PAPERS, PROJECTS AND TALKS

- **On admissible fourier coefficients of modular forms of weight 2 and $2k+1$** *June 2021*
Published in the Annales mathématiques du Québec
 - For weight 2 normalized newforms $f(z)$ defined over \mathbb{Q} and trivial residual mod 2 Galois representation we rule out or locate all odd prime values $|\ell| < 100$ of their Fourier coefficients $a(n)$ when n satisfies certain congruences. We also study the case of odd weights $k \geq 1$ newforms where the nebentypus is given by a quadratic Dirichlet character.
- **Elliptic curves of prime conductor - an exploration of conjecture, data and bias** *October 2022*
Masters Thesis, supplemental code available here
 - I was granted access to a complete data set containing all elliptic curves over \mathbb{Q} of prime conductor $p \leq 2 \cdot 10^{13}$. Utilized Andrew Sutherland's *C* libraries *smalljac* and *ffpoly* in order to optimize code which sieves through the data set and classifies the rank of curves. The goal of this project was to answer the following question: how does the family \mathcal{E}_{pr} of prime conductor elliptic curves compare the more general family \mathcal{E} of all elliptic curves? In this paper I analyse whether the data fits the best current heuristics regarding models for invariants such as the rank r , the Tate-Shavarevich group \mathfrak{m} , the selmer group as well as many of the other invariants such as those which appear in the BSD conjecture. We also give evidence towards previously undetected biases in certain invariants and conjecture as to why they occur. Moreover, we identify the first the first occurrences of a rank $0 \leq n \leq 7$ curve ordered by conductor and produce two algorithms which search for high rank elliptic curves of prime conductor. Trained various Machine Learning models on our data set in order to build high accuracy probabilistic classifiers for quantities such as the rank and the analytic order of the Sha group \mathfrak{m} .

- **A quest for 5 dimensional Calabi-Yau Manifolds using Genetic Algorithms**

Preprint available shortly.

Feb 2024

- Calabi-Yau Manifolds are of central importance in Physics (String Theory) and Mathematics. Canonically, these objects can be associated to reflexive lattice polytopes. We make improvements to the Genetic Algorithm proposed by Berglund et al. in order to generate polytopes in a much larger search space, greatly expanding the database of reflexive polytopes in 5 dimensions.

- **On the Machine Learning of the ranks of Elliptic curves using Tree-based models**

Paper available soon. Related code here

October 2023

- In this paper we make an advancement in the prediction of ranks of elliptic curves or prime conductor using Machine learning methods. We explore the theoretical framework in place which helps us make predictions about the behaviour of this invariant. Moreover, we present heuristic and computational evidence towards biases in the ranks, conductors and coefficients of elliptic curves within the latter family. The results from this paper were presented at the DANGER 3 workshop in London.

- **Dual Linear Programming Bounds and Modular Forms**

Current preprint version available here and code here

September 2022

- Cohn and Elkies developed a method to achieve upper bounds for sphere packing densities in \mathbb{R}^d using techniques from linear programming. This method is sharp in dimensions 8 and 24 but is conjectured to not be sharp in any other dimension $d > 2$. Cohn and Triantafyllou later proved that it yields results far from the best known packings in dimensions 12, 16, 20, 28, and 32. This article shows how to generalize their method to arbitrary dimensions using modular forms of integral and half-integral weights. Moreover, it aims to show that this method isn't sharp for small dimensions d and to provide evidence supporting the latter conjecture.

- **Modular Forms of Half-Integral Weight and the Congruent Number Problem**

Honours Research Project

June 2020

- Studied how half-integral weight modular forms arise as eigen-forms of certain Hecke operators. Discussed the Shimura Correspondence and the Theorem of Waldspurger regarding the bridge between integral and half-integral weight forms as well as their applications to the congruent number problem which asks whether a given square-free integer n is permissible as the area of some right angle triangle. Link to the file.

- **“The E_8 lattice And It's Many Mysteries”**

Term Presentation in Lie Theory Course

December 2022

- I gave a talk discussing the E_8 lattice as well as the many problems across the sciences in which it (at times surprisingly) arises. Discussed the historical setting behind the Cartan-Killing classification effort of simple Lie groups/Lie algebras as well as the initial discovery of the E_8 lattice by H.J.S. Smith using his mass formula for even unimodular lattices. Gave a brief introduction as to how E_8 appears in the string theory, sphere packing, Hamming codes as well as many other problems. Gave an overview of the proof of “Universal Optimality of the E_8 and Leech lattices” - an astonishing result of Cohn, Kumar, Miller, Radchenko and Viasovska. Link to the slides.

- **“A review of Hecke Theory”**

Higher Algebra 1 Final Project

Fall 2021

- I wrote an expository paper on the origins of Hecke Theory and discussed multiple results which stem from it such as a generalization of a theorem of Shimura in his 1958 paper “Correspondances modulaires et les fonctions ζ de courbes algébriques” which relates the L -function of an abelian variety A induced by some modular form f to the L -function of f itself. Link to the file.

- **Seminar of Undergraduate Mathematics in Montreal (SUMM)**

“Fun With The Fundamental Group”

January 2019

- Gave an introductory talk discussing the fundamental group of a topological space. Briefly discussed the Seifert-van Kampen Theorem and gave a proof of the Fundamental Theorem of Algebra using $\pi_1(S^1)$. Link to the slides.

- **“Spherical Harmonics and Representations of Lie Groups”**

Topics Course in Spectral Theory

April 2020

- As a term project in a course on spectral theory, I gave a brief talk discussing why spherical harmonics end up generating all irreducible representations of $SO(3)$. Link to the slides.

AWARDS

- Faculty of Science Graduate Award 2022
- Faculty of Science Graduate Award 2021

TECHNICAL SKILLS & MISCELLANY

- **Programming Languages:** Python, C, Nix, OCaml, \LaTeX
- **Technologies:** Sage, Magma, PARI+GP , Bash, Pandas, TensorFlow
- **Spoken Languages:** English, French, Greek, Spanish, Portuguese
- **Citizenship:** Canadian, Greek