David Lowry-Duda

Contact Information

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Academic Appointments

Senior Research Scientist September 2019 to present

Institute for Computational and Experimental Research in Mathematics

- Supervisor: Brendan Hassett
- Research and produce mathematical software in number theory, arithmetic geometry, and algebraic geometry.
- Supported by the Simons Collaboration in Arithmetic Geometry, Number Theory, and Computation via the Simons Foundation grant 546235.

Postdoctoral Researcher August 2017 to September 2019

Warwick Mathematics Institute, University of Warwick

- Supervisor: John Cremona
- Helped develop and maintain the L-Function and Modular Form Database – source available at https://github.com/LMFDB/lmfdb
- Supported by the Engineering and Physical Science Research Council grant "EP/K034383/1 LMF: L-Functions and Modular Forms"

Education

Brown University, Providence, RI

Ph.D., Mathematics, 2017

- Adviser: Professor Jeff Hoffstein
- Thesis: On Some Variants of the Gauss Circle Problem
- Supported by an NSF Graduate Student Fellowship

MSc, Mathematics, 2015

Georgia Institute of Technology, Atlanta, GA

B.S., Applied Mathematics, *summa cum laude*, 2011

B.S., International Affairs and Modern Languages, *summa cum laude*, 2011

Research Publications and Products

[1] Jonathan Bober, Andrew R. Booker, Min Lee, and David Lowry-Duda. *Murmurations of Modular Forms in the weight aspect.* Arxiv: https://arxiv.org/abs/2310.07746.

[2] Chan Ieong Kuan, David Lowry-Duda, and Alexander Walker. *Counting divisors in the outputs of a binary quadratic form.* Arxiv: https://arxiv.org/abs/2310.13632.

[3] Abbey Bourdon, Sachi Hashimoto, Timo Keller, Zev Klagsbrun, David Lowry-Duda, Travis Morrison, Filip Najman, and Himanshu Shukla. *Towards a Classification of Isolated j-invariants.* Preprint: https://davidlowryduda.com/static/files/BHKKLDMNS_draft.pdf. Code: https://github.com/davidlowryduda/isolated_points. (Will soon be on the arxiv).

[4] David Lowry-Duda and Andrei Seymour-Howell. *Evidence for Murmurations of Maass Forms.* Preprint soon available; based on data at https://davidlowryduda.com/maass-murmurations/.

[5] Chan Ieong Kuan, David Lowry-Duda, Alexander Walker, and Raphael S. Steiner. *Sums of Cusp Form Coefficients Along Quadratic Sequences.*
Arxiv: https://arxiv.org/abs/2301.11901.

[6] Theresa C. Anderson, Ayla Gafni, Kevin Hughes, Robert J. Lemke Oliver, David Lowry-Duda, Frank Thorne, Jiuya Wang, and Ruixiang Zhang. *Improved bounds on number fields of small degree.*
Arxiv: https://arxiv.org/abs/2204.01651.

[7] David Lowry-Duda, *Sign changes of cusp form coefficients on indices that are sums of two squares.*
Arxiv: https://arxiv.org/abs/2108.12520.

[8] Thomas Hulse, Chan Ieong Kuan, David Lowry-Duda, and Alexander Walker, *Arithmetic progressions of squares and multiple Dirichlet series.*
Arxiv: https://arxiv.org/abs/2007.14324.

[9] Anupam Datta, Nir Elber, Raymond Feng, David Lowry-Duda, and Henry Xie, *Prime sums.* (Comes from PROMYS 2021 young scientist research project).
Arxiv: https://arxiv.org/abs/2111.02795.

[10] Theresa C. Anderson, Ayla Gafni, Robert J. Lemke Oliver, David Lowry-Duda, George Shakan, and Ruixiang Zhang, *Quantitative Hilbert irreducibility and almost prime values of polynomial discriminants.* To appear in International Mathematics Research Notices.
Arxiv: https://arxiv.org/abs/2107.02914.

[11] David Lowry-Duda, Takashi Taniguchi, and Frank Thorne, *Uniform bounds for lattice point counting and partial sums of zeta functions.* To appear in Mathematische Zeitschrift.
Arxiv: https://arxiv.org/abs/1710.02190.

[12] David Lowry-Duda, *Visualizing modular forms.*
To appear in the *Arithmetic Geometry, Number Theory, and Computation* volume in Simons Symposia series.
Arxiv: https://arxiv.org/abs/2002.05234.

[13] David Lowry-Duda. `phasemagplot`, a tool to visualize complex-valued functions in SageMath. Beginning with `sage9.6`, this powers the standard complex plotting function `complex_plot` in SageMath.
Reference version with DOI https://doi.org/10.5281/zenodo.4035117.
Code: https://github.com/davidlowryduda/phase_mag_plot.

[14] David Lowry-Duda with an appendix by Brendan Hassett, *Congruent numbers with the same hypotenuse.*
To appear in the *Arithmetic Geometry, Number Theory, and Computation* volume in Simons Symposia series.
Arxiv: https://arxiv.org/abs/2002.01024.

[15] Alex J. Best, Jonathan Bober, Andy R. Booker, Edgar Costa, John Cremona, Martin Derickx, David Lowry-Duda, Min Lee, David Roe, Andrew V. Sutherland, and John Voight. *Computing classical modular forms.*
To appear in the *Arithmetic Geometry, Number Theory, and Computation* volume in Simons Symposia series.
Arxiv: https://arxiv.org/abs/2002.04717.

[16] Thomas Hulse, Chan Ieong Kuan, David Lowry-Duda, and Alexander Walker, *Triple Correlation Sums of Coefficients of Cusp Forms.*
Journal of Number Theory 220 (2021): 1–18.
DOI: 10.1016/j.jnt.2020.08.007.
Arxiv: https://arxiv.org/abs/1911.09216.

[17] Thomas Hulse, Chan Ieong Kuan, David Lowry-Duda, and Alexander Walker, *The Laplace Transform of the Second Moment in the Gauss Circle Problem.* Algebra and Number Theory 15 No. 1 (2021): 1–27.
DOI: 10.2140/ant.2021.15.1.
Arxiv: https://arxiv.org/abs/1705.04771.

[18] David Lowry-Duda and Adam Sakareassen, *Towards Flying through Modular Forms.*
Proceedings of Bridges, 2021.
Arxiv: https://arxiv.org/abs/2104.15116.

[19] David Lowry-Duda, *Non-real poles and irregularity of distribution.*
Journal of Number Theory 217 (2020): 23–35.
DOI: 10.1016/j.jnt.2020.05.007.
Arxiv: https://arxiv.org/abs/1910.09969.

[20] David Lowry-Duda and Miles Wheeler, *Perturbing the Mean Value Theorem: Implicit Functions, the Morse Lemma, and Beyond.* The American Mathematical Monthly 128.1 (2020): 50–61.
Winner of the Paul R. Halmos–Lester R. Ford Award.
DOI: 10.1080/00029890.2021.1840879.
Arxiv: https://arxiv.org/abs/1906.02026.

[21] Thomas Hulse, Chan Ieong Kuan, David Lowry-Duda, and Alexander Walker, *A Shifted Sum for the Congruent Number Problem.*
Ramanujan Journal (2019): 1–8.
DOI: 10.1007/s11139-018-0131-7.
Arxiv: https://arxiv.org/abs/1804.02570.

[22] Thomas Hulse, Chan Ieong Kuan, David Lowry-Duda, and Alexander Walker, *Second Moments in the Generalized Gauss Circle Problem.* Forum of Math, Sigma 6 (2018): e24.
DOI: 10.1017/fms.2018.26.
Arxiv: https://arxiv.org/abs/1703.10347.

[23] Alina Bucur, Edgar Costa, Chantal David, João Guerreiro, David Lowry-Duda, *Traces, High powers and One level density for families of curves over finite fields*, Math. Proc. of the Cambridge Philosophical Society, Vol. 165 No. 2 (2018): 225–248.
DOI: 10.1017/S030500411700041X.
Arxiv: https://arxiv.org/abs/1610.00164.

[24] John Cremona, Michael Kohlhase, David Lowry-Duda, Dennis Müller, Markus Pfeiffer, Florian Rabe, Nicolas M. Thiéry, and Tom Wiesing. *GAP/SAGE/LMFDB Interface Theories and Alignment in OMDoc/MMT for System Interoperability.*
Part of OpenDreamKit reports 2018.
Available at: https://github.com/OpenDreamKit/OpenDreamKit/blob/master/WP6/D6.5/report-final.pdf.

[25] Thomas Hulse, Chan Ieong Kuan, David Lowry-Duda, and Alexander Walker, *Short-Interval Averages of Sums of Fourier Coefficients of Cusp Forms*, Journal of Number Theory 173 (2017): 394–415.

DOI: 10.1016/j.jnt.2016.09.004.
Arxiv: http://arxiv.org/abs/1512.05502.

[26] Thomas Hulse, Chan Ieong Kuan, David Lowry-Duda, and Alexander Walker, *Sign Changes of Coefficients and Sums of Coefficients of L-functions*, Journal of Number Theory 177 (2017): 112–135.
DOI: 10.1016/j.jnt.2017.01.007.
Arxiv: http://arxiv.org/abs/1606.00067.

[27] Thomas Hulse, Chan Ieong Kuan, David Lowry-Duda, and Alexander Walker, *The Second Moment of Sums of Coefficients of Cusp Forms*, Journal of Number Theory 173 (2017): 304–331.
DOI: 10.1016/j.jnt.2016.09.005.
Arxiv: http://arxiv.org/abs/1512.01299.

[28] Paul Carter and David Lowry-Duda, *On Functions Whose Mean Value Abscissas are Midpoints, with Connections to Harmonic Functions*, Amer. Math. Monthly Vol. 124 No. 6 (2017): 535–542.
DOI: 10.4169/amer.math.monthly.124.6.535.
Arxiv: http://arxiv.org/abs/1608.02558.

[29] David Lowry-Duda, *On Some Variants of the Gauss Circle Problem*.
PhD Thesis. Brown University Dissertation Archive.
Arxiv: https://arxiv.org/abs/1704.02376.

[30] David Lowry-Duda, *Unexpected Conjectures about -5 Modulo Primes*. College Math. J. Vol 46 No. 1 (2015): 56–57.
DOI: 10.4169/college.math.j.46.1.56.

Selected Talks

I make notes and slides for many of my talks available on my website. Notes are also usually available on request. I highlight 30 of my recent talks here.

[1] *Modular Murmurations*, Maine-Québec Number Theory Conference 2023 (University of Maine). October 2023.

[2] *Sums of coefficients of modular forms*, Boston College Number Theory Seminar. April 2023.

[3] *Counting polynomials and number fields*, University of Connecticut Number Theory Seminar. March 2023.

[4] *Modular forms and their L-functions*, Stony Brook Center for Geometry and Physics, November 2022.

[5] *An introduction to the Langlands program*, Stony Brook Center for Geometry and Physics, November 2022.

[6] *Counting number fields of bounded discriminant*, Maine-Québec Number Theory conference, October 2022.

[7] *Computing and verifying Maass forms*, BYU Number Theory seminar, Provo, UT, March 2022.

[8] *Mathematics and computation: how computation and experimentation inform research*, BYU *Focus on Math* seminar, Provo, UT, March 2022.

[9] *Counting number fields with small Galois group*, Brown University Algebra seminar, Providence, RI, October 2021.

[10] *Zeros of half integral weight Dirichlet series*, Maine–Québec Number Theory Conference, (remotely via zoom), October 2021.

[11] *Visualizing modular forms*, University of Oregon Number Theory seminar, (remotely via zoom), May 2021.

[12] *Empirically studying half-integral weight modular forms*, Ole Miss Number Theory seminar, (remotely via zoom), March 2021.

[13] *Lattice points and sums of Fourier coefficients of modular forms*, AIM Workshop on Arithmetic Statistics, Discrete Reduction, and Fourier Analysis, American Institute of Math, CA, (remotely via zoom), February 2021.

[14] *Computing and verifying Maass forms*, Rutgers Number Theory seminar, (remotely via zoom), February 2021.

[15] *How should we visualize modular forms?*, Bowdoin Number Theory Day, Brunswick, ME, USA, November 2019.

[16] *The Congruent Number Problem*, Brown University Algebra Seminar, Providence, RI, USA, November 2019.

[17] *Arithmetic problems with Dirichlet series having lines of poles: Proving $\Omega_{\pm}$ results*, Maine–Québec Number Theory Conference, October 2019.

[18] *Zeros of Half-Integral Weight L-functions*, 2019 Joint Math Meetings, Baltimore, MD, January 2019.

[19] *The Gauss Sphere Problem and Modular Forms*, Exeter Number Theory Seminar, Exeter, UK, October 2018.

[20] *Half-Integral Weight Modular Forms*, Bristol Heilbronn Number Theory Seminar, Bristol, UK, October 2018.

[21] *The Gauss Sphere Problem and Modular Forms*, Brown University Algebra Seminar, Providence, RI, USA, September 2018.

[22] *The Gauss Circle and Sphere Problem*, Tufts Number Theory Seminar, Medford, MA, USA, September 2018.

[23] Counting Lattice Points on Spheres and Hyperboloids. 4th EU/US Workshop on Automorphic Forms and Related Topics, Budapest, Hungary, July 2018.

[24] *Recent Progress on the generalized Gauss Circle Problem, and related topics*, Bristol Linfoot Number Theory Seminar, Bristol, UK, February 2018.

[25] *Recent progress on the generalized Gauss Circle Problem, and related topics on sums of coefficients of modular forms*, Nottingham Number Theory Seminar, Nottingham, UK, November 2017.

[26] *On Analogies of the Gauss Circle Problem*, Warwick Number Theory Seminar, Coventry, UK, October 2017.

[27] *On Problems Related to the Gauss Circle Problem*, Dartmouth Number Theory Seminar, Dartmouth, NH, March 2017.

[28] *Counting Points on One-Sheeted Hyperboloids*, MSRI Number Theory Seminar, Berkeley, CA, February 2017.

[29] *Sign Changes of Sums of Fourier Coefficients of Cusp Forms*, Texas A&M Number Theory Seminar, Texas A&M, TX, May 2015.

[30] *The Mean Value Theorem and Why It's Not Useless*, Bard College at Simon's Rock, Bard College, MA, May 2015.

Teaching Experience

Brown University, Providence, RI

Teaching Fellow for Math 100: Calculus II **Fall 2016**
(Some Course Materials and student evaluations are available at request)

Teaching Fellow for Math 420: Elementary Number Theory **Spring 2016**
(Some Course Materials and student evaluations are available at request)

Teaching Consultant for Brown University **2014–2016**

- Observed and provided feedback to improve other instructors' teaching
- Associated to the Sheridan Center for Teaching and Learning at Brown

Lead Instructor for Summer Number Theory **Summers 2013 to 2015**

- Created for adventurous high school students as part of Summer@Brown.
- Responsible for course design and 15 hours of instruction per week.

Teaching Fellow for Math 170: Advanced Placement Calculus II **Fall 2014**
(Some student evaluations are available at request)

Teaching Assistant for Math 100: Calculus II **Fall 2013**

Teaching Assistant for Math 90: Calculus I **Fall 2012**
(Some Course Materials and student evaluations are available at request)

Academic Tutor in the Brown Math Resource Center **2011–2014**

Georgia Institute of Technology, Atlanta, GA

Teaching Assistant for Math 2401: Calculus III **Spring 2011**

Teaching Assistant for Math 1502: Calculus II **Spring 2008 and Fall 2010**

Teaching Assistant for Math 1501: Calculus I **Fall 2009**

Academic Tutor in the Georgia Tech MathLab **2008–2011**

Student Supervision

I was the primary supervisor for each project listed. I've also helped supervise several other students as secondary advisors or in less formal capacities.

Smitali Bhandari, **Twyla Colburn**, **Patrick Lu**, and **Haran Mouli**. Four high schoolers working together on a research project in summer of 2022, at BU Program in Mathematics for Young Scientists (PROMYS2022).
Project title: *Königsberg Pseudoprimes*.
Preprint available on request.

Nir Elber, **Raymond Feng**, and **Henry Xie**. Three high schoolers working together on a research project in summer of 2021, at BU Program in Mathematics for Young Scientists (PROMYS2021).
Project title: *Prime sums*.
See their report at https://davidlowryduda.com/project-report-on-prime-sums/ or https://arxiv.org/abs/2111.02795.

Andrew Darlington. MSc Student, academic year 2018–2019, at the University of Warwick.
MSc Research project title: *Half-integral weight modular forms*.

Eleri Williams. URSS (Undergraduate Research Support Scheme) at the University of Warwick, Summer 2018.
Project title: *Primes of the form* $x^2 + am^2$.

Andrew Darlington. URSS (Undergraduate Research Support Scheme) at the University of Warwick, Summer 2018.
Project title: *Counting representations as sums of squares*.

Professional Service

Workshops Organized:

- *Open-Source Cyberinfrastructure Supporting Mathematics*, 4–8 December 2023 at the American Institute of Mathematics. Coorganized with Robert Beezer and Steven Clontz.

Conferences Organized:

- Coorganizer for *Second Annual Conference of Graduate Students of the Brown University Chapter of the American Mathematical Society*, 21 February 2015.
- Lead organizer for *Graduate Student Conference of the Brown University Chapter of the American Mathematical Society*, 1 March 2014.

Conference Sessions Organized:

- Lead organizer for *Arithmetic Geometry with a View Toward Computation*, three sessions to be held at the Joint Math Meetings 2024 in San Francisco. Coorganizers were Barinder Banwait, Shiva Chidambaram, Brendan Hassett, Juanita Rosero, and Ciaran Schembri.

Seminars Organized:

- *Brown University Algebra Seminar*, 2021.
- *University of Warwick Number Theory Seminar*, 2017–2019.

Journals Refereed for:

- *Algebra and Number Theory*
- *American Mathematical Monthly*
- *Fibonacci Quarterly*
- *International Journal of Number Theory*
- *Journal of the London Mathematical Society*
- *Journal of Number Theory*
- *Mathematical Gazette*
- *Mathematics Magazine*
- *Mathematische Zeitschrift*
- *Research in Number Theory*
- *Rocky Mountain Journal of Math*

zbMATH reviewer

Exhibited Art

I make mathematically-inspired artwork and visualizations related to my research. Here, I list a few of the locations where my artwork has been displayed. I note several other conferences and seminars use my work as well.

[1] Visualizations for Quanta's article *New proof distinguishes mytserious and powerful 'modular forms'*, 2023. See https://www.quantamagazine.org/long-sought-math-proof-unlocks-more-mysterious-modular-forms-20230309/.

[2] Visualizations for Quanta's article *What is the Langlands Program?*, 2022. See https://davidlowryduda.com/quanta-langlands-viz/ for more, and links to the article.

[3] Visualizations for Spectrum der Wissenschaft (a German popular science magazine) article *Langlands-Programm die Vereinheitlichung der Mathematik*, April 2022.

[4] Dong-A Science, a monthly science magazine in South Korea, 2021.

[5] Logo for MSRI workshop on Algebraic Cycles, L-Values, and Euler Systems (which will occur in 2023).

[6] Logo for LMFDB, Computation, and Number Theory (LuCaNT) conference (which will occur in 2023).

[7] Joint Math Meetings 2021 Art Gallery, Low-resolution images and descriptions available at http://gallery.bridgesmathart.org/exhibitions/2021-joint-mathematics-meetings/davidlowryduda.

[8] Cover for the Proceedings of the Royal Society Series A, August 2020.

Other Service

Developer and significant contributor to the *L*-functions and modular forms database (LMFDB.org).

Moderator and frequent contributor to Math.StackExchange; also regular contributor to MathOverflow and StackOverflow.

Grants, Awards, and Honors

Mathematical Association of America

- Paul R. Halmos–Lester R. Ford Award for article *Perturbing the Mean Value Theorem: Implicit Functions, the Morse Lemma, and Beyond*. Joint with Miles H. Wheeler. 2022.

National Science Foundation

- Graduate Research Fellowship. 2012–2017
- Graduate Research Fellowship Honorable Mention. 2011
- Mentoring Through Critical Transition Points Scholarship recipient. 2009–2010

Sheridan Center for Teaching and Learning

- Certificate I: Reflective Teaching, 2012
- Certificate IV: Teaching Consultant Program, 2014–2015.

Georgia Institute of Technology

- Ronald L. Martin President's Scholarhip, 2007–2011.
- Reginald S. Fleet Scholarship, for study in Budapest, Hungary, 2010.
- Reginald S. Fleet Scholarship, for study in Brussels, Belgium, 2009.
- Reginald S. Fleet Scholarship, for study in Mexico City, Mexico, 2008.

Citizenship

USA