Edgar Costa

Curriculum Vitæ

Research Interests

Effective methods in **arithmetic geometry**, **arithmetic statistics**, and **number theory**.

Appointments and Visiting Positions

2018- **Massachusetts Institute of Technology**, *Research Scientist*

2015-2018 **Dartmouth College**, *Instructor in Applied and Computational Mathematics*

Fall 2015 **Institute for Computational and Experimental Research in Mathematics**, *Brown University*
Postdoctoral Fellow for the semester program: Computational Aspects of the Langlands Program

Education

2010-2015 **Courant Institute of Mathematical Sciences**, *New York University*, Ph.D. in Mathematics
- Thesis title: Effective computations of Hasse-Weil zeta functions
- Advisor: Yuri Tschinkel
- Awarded Kurt Friedrichs Prize for an outstanding dissertation.

2008-10 **Instituto Superior Técnico**, *Universidade de Lisboa*, MSc in Mathematics and Applications
- Master Thesis: Étale Cohomology
- Advisors: Pedro Ferreira dos Santos (IST) and Roy Skjelnes (KTH)

Fall 2009 **KTH - Kungliga Tekniska högskolan**, *Erasmus exchange programme*

2005-08 **Instituto Superior Técnico**, *Universidade de Lisboa*, BSc in Applied Mathematics and Computation

Publications and Preprints (by date of completion)

[22] **A database of basic numerical invariants of Hilbert modular surfaces**
with Eran Assaf, Angelica Babei, Ben Breen, Juanita Duque-Rosero, Aleksander Horawa, Jean Kieffer, Avinash Kulkarni, Grant Molnar, Sam Schiavone, and John Voight
submitted, arXiv:2301.10302

[21] **Computing isogeny classes of typical principally polarized abelian surfaces over the rationals**
with Raymond van Bommel, Shiva Chidambaram, and Jean Kieffer
submitted, arXiv:2301.10118

[20] **Counting points on smooth plane quartics**
with David Harvey, and Andrew V. Sutherland
Fifteenth Algorithmic Number Theory Symposium, Research in Number Theory 9 (2023), no 1

[19] **Abelian varieties of prescribed order over finite fields**
with Raymond van Bommel, Wanlin Li, Bjorn Poonen, and Alexander Smith
submitted, arXiv:2106.13651

[18] **Hypergeometric L-functions in average polynomial time**
with Kiran Kedlaya, and David Roe
Fourteenth Algorithmic Number Theory Symposium, Open Book Series 4 (2020), 143–159

[17] **Effective obstruction to lifting Tate classes from positive characteristic**
with Emre Sertöz
Arithmetic geometry, number theory, and computation, Simons Symposia (2021), 293–333

[16] **Computing classical modular forms**
with Alex J. Best, Jonathan Bober, Andrew R. Booker, John Cremona, Maarten Derickx, David Lowry-Duda, Min Lee, David Roe, Andrew V. Sutherland, and John Voight
Arithmetic geometry, number theory, and computation, Simons Symposia (2021), 123-213

[15] **Restrictions on Weil polynomials of Jacobians of hyperelliptic curves**
with Ravi Donepudi, Ravi Fernando, Valentijn Karemaker, Caleb Springer, and Mckenzie West
Arithmetic geometry, number theory, and computation, Simons Symposia (2021), 259–276

[14] **Arithmetic invariants from Sato-Tate moments**
with , and Andrew V. Sutherland
Comptes Rendus Mathematique, 357 (2019), 823-826

[13] **Zen and the Art of Database Maintenance**
with David Roe
Arithmetic geometry, number theory, and computation, Simons Symposia (2021), 277–292

[12] **Identifying central endomorphisms of an abelian variety via Frobenius endomorphisms**
with Davide Lombardo, and John Voight
Research in Number Theory, 7 (2021), no. 3, 46

[11] **Computing Zeta Functions of Cyclic Covers in Large Characteristic**
with Vishal Arul, Alex J. Best, Richard Magner, and Nicholas Triantafillou
Thirteenth Algorithmic Number Theory Symposium, The Open Book Series 2 (2019), 37–53

[10] **Zeta functions of nondegenerate hypersurfaces in toric varieties via controlled reduction in p-adic cohomology**
with David Harvey, and Kiran Kedlaya
Thirteenth Algorithmic Number Theory Symposium, Open Book Series 2 (2019), 221–238

[9] **Rigorous computation of the endomorphism ring of a Jacobian**
with Nicolas Mascot, Jeroen Sijsling, and John Voight
Mathematics of Computation, 88 (2019), 1303-1339

[8] **On the arithmetic of a family of degree-two K3 surfaces**
with Florian Bouyer, Dino Festi, Chris Nicholls, and Mckenzie West
Mathematical Proceedings, 166 (2018), no. 3, 523-542

[7] **On the distribution of the Picard ranks of the reductions of a K3 surface**
with Andreas-Stephan Elsenhan, and Jörg Jahnel
Research in Number Theory, 6 (2020), no. 3, 27 (2020)

[6] **Traces, High powers and one level density for families of curves over finite fields**
with Alina Bucur, Chantal David, João Guerreiro, and David Lowry-Duda
Mathematical Proceedings, 162 (2018), no. 2, 225–248

[5] **Effective computations of Hasse-Weil zeta functions**
Ph.D. thesis, New York University (2015)

[4] **Variation of Néron-Severi ranks of reductions of K3 surfaces**
with Yuri Tschinkel
Experimental Mathematics, 23 (2014), 475-481.

[3] **Asymptotic expansions, L-values and a new Quantum Modular Form**
The Ramanujan Journal, 35 (2014), 141-148

[2] **A search for Wilson primes**
with Robert Gerbicz, and David Harvey
Mathematics of Computation, 82 (2014), 3071-3091

[1] **Faster deterministic integer factorization**
with David Harvey
Mathematics of Computation, 83 (2014), 339-345

Editorial Positions

2023 **Associate editor: LMFDB, Computation, and Number Theory (LuCaNT)**
`lucant.org/`

2022 **Program committee: Algorithmic Number Theory Symposium, ANTS-XV**
`antsmath.org/`

2018- **Associate editor: The L-functions and Modular Forms Database**
`www.lmfdb.org`

Grants, Awards, and Honors

2022 **Building Community award**
Massachusetts Institute of Technology, Math department

2020 **COVID-19 Hero Award**
Massachusetts Institute of Technology, School of Science

2020 **Infinite Kilometer Award**
Massachusetts Institute of Technology, School of Science

2016-2018 **CompX Faculty Grant by the Neukom Institute**, *co-PI*
$27 000 to work on and host the L-Functions and Modular Forms Database (LMFDB)

2015 **Kurt Friedrichs Prize**
This prize is awarded for an outstanding dissertation in mathematics.

2010-2015 **Henry M. MacCracken Fellowship**
PhD fellowship

2010-2014 **Fundação para a Ciência e a Tecnologia PhD Scholarship**
PhD fellowship

2009 **Universidade de Lisboa: academic merits award**

2008-2010 **Instituto Superior Técnico, Science and Technology fellowship**
To manage, improve and develop the information systems of the Mathematics Department

2008 **Honors in the Prof. Jaime Campos Ferreira Prize**
This prize is awarded for outstanding academic merits in the area of Mathematics

2008 **Universidade de Lisboa: academic merits award**

2007 **Novos Talentos da Matemática, by Calouste Gulbenkian Foundation**
This prize is awarded to estimulate promising students to pursue research in Mathematics

2006 **Novos Talentos da Matemática, by Calouste Gulbenkian Foundation**
This prize is awarded to estimulate promising students to pursue research in Mathematics

2006 **Universidade de Lisboa: academic merits award**

2005 **Prize of Caixa Geral de Depósitos**
This prize is awarded for academic merits

Talks

Jan 2023 **Computing isogeny classes of principally polarized abelian surfaces over the rationals**
Simons Collaboration on Arithmetic Geometry, Number Theory, and Computation Annual Meeting

Jan 2023 **Computing isogeny classes of principally polarized abelian surfaces over the rationals**
Joint Mathematics Meetings

Dec 2022 **Computing isogeny classes of principally polarized abelian surfaces over the rationals**
Palmetto Number Theory Series (PANTS)

Dec 2023 **Computing isogeny classes of principally polarized abelian surfaces over the rationals**
University of Washington

Aug 2022 **Counting points on smooth plane quartics**
Algorithmic Number Theory Symposium XV, University of Bristol

Jun 2022 **Geometric invariants from counting points**
Connecticut Summer School in Number Theory

Dec 2021 **The L-functions and modular forms database**
William & Mary

Apr 2021 **Effective obstruction to lifting Tate classes from positive characteristic**
Columbia-CUNY-NYU number theory seminar

Jan 2021 **From counting points to rational curves on K3 surfaces**
Vantage seminar

Dec 2020 **Effective obstruction to lifting Tate classes from positive characteristic**
Saarland University

Oct 2020 **Bounding Picard numbers**
Simons Collaboration on Arithmetic Geometry, Number Theory, and Computation

May 2020 **From Frobenius polynomials to geometry**
Around Frobenius distributions and related topics

Feb 2020 **Frobenius Distributions**
Department of Mathematics, University of California San Diego

Jan 2020 **Computing central endomorphisms of an abelian variety via reductions modulo p**
Joint Mathematics Meetings

Jan 2020 **Variation of Néron-Severi ranks of reductions of K3 surfaces**
Joint Mathematics Meetings

Nov 2019 **Rigorous computation of the endomorphism ring of a Jacobian**
University of New South Wales

May 2019 **Variation of Néron-Severi ranks of reductions of K3 surfaces**
The University of Tennessee, Knoxville

Apr 2019 **Frobenius Distributions**
Department of Mathematics, University of Washington

Jan 2019 **Upper bounds for the endomorphism algebra of an abelian variety**
Joint Mathematics Meetings

Nov 2018 **Randomness in number theory**
Department of Mathematics, Colorado Sate University

Oct 2018 **Frobenius Distributions**
Colóquio de Geometria e Aritmética Rio de Janeiro

Sep 2018 **Frobenius Distributions**
Massachusetts Institute of Technology

Jul 2018 **Computing zeta functions of nondegenerate hypersurfaces in toric varieties**
Algorithmic Number Theory Symposium XIII, University of Wisconsin, Madison

Jun 2018 **Distributions in arithmetic geometry**
Communicating Mathematics Effectively, University of Washington

May 2018 **Computing zeta functions of nondegenerate hypersurfaces in toric varieties**
Birational Geometry and Arithmetic, ICERM, Brown University

Dec 2017 **Computing zeta functions of nondegenerate toric hypersurfaces**
Department of Mathematics & Statistics, Boston University

Oct 2017 **Computing zeta functions of nondegenerate toric hypersurfaces**
Maine-Québec Number Theory Conference

Oct 2017 **Computing zeta functions of nondegenerate toric hypersurfaces**
Banff International Research Station, p-adic Cohomology and Arithmetic Applications

Mar 2017 **Toric point counting and applications**
Banff International Research Station, New Trends in Arithmetic and Geometry of Algebraic Surfaces

Feb 2017 **Toric point counting and applications**
Department of Mathematics & Statistics, University of Vermont

Oct 2016 **Counting points on curves**
Université Laval, Québec, Québec-Maine Number Theory Conference

Jul 2016 **Counting points on curves**
University of New South Wales

Mar 2016 **Zeta functions of quartic K3 surfaces over $\mathbf{F}_3$**
Sage Days 71: Explicit p-adic methods in number theory, Oxford University

Jan 2016 **Equidistributions in arithmetic geometry**
Dartmouth College

Dec 2015 **Equidistributions in arithmetic geometry**
Instituto Superior Técnico

Oct 2015 **Effective computations of Hasse-Weil zeta functions**
Explicit Methods for Modularity of K3 Surfaces and Other Higher Weight Motives, ICERM, Brown University

May 2015 **Effective computations of Hasse-Weil zeta functions**
Courant Institute of Mathematical Sciences, NYU

Feb 2015 **Variation of Néron-Severi ranks of reductions of algebraic surfaces**
Department of Mathematics, Rice University

Oct 2014 **Variation of Néron-Severi ranks of reductions of algebraic surfaces**
School of Mathematics and Statistics, UNSW

Oct 2014 **Variation of Néron-Severi ranks of reductions of algebraic surfaces**
Courant Institute of Mathematical Sciences, NYU

Dec 2012 **The point counting problem**
Courant Institute of Mathematical Sciences, NYU

Jan 2012 **Faster deterministic integer factorization**
Courant Institute of Mathematical Sciences, NYU

Mar 2011 **Étale Cohomology**
Courant Institute of Mathematical Sciences, NYU

Jul 2010 **Étale Cohomology**
Departamento de Matemática, Instituto Superior Técnico

Advising and mentoring

Undergraduate research

Summer 2019 **Jeffery Yu**, *Massachusetts Institute of Technology*
Supersingular primes

Summer 2019 **Andy Dienes**, *Massachusetts Institute of Technology*
Remainder tree algorithms

Summer 2019 **Daniel Liu**, *Massachusetts Institute of Technology*
Remainder tree algorithms

Spring 2017 **John E. Martin**, *Dartmouth College*
L-functions of elliptic curves over quadratic fields

Summer 2014 **Jonathan H. Friedman**, *New York University*
Behavior of the Geometric Picard Ranks of Abelian Surfaces over $\mathbb{Q}$

Professional Service

Dec 2022 **Organizer: Hilbert Modular forms workshop II**

Nov 2022 **Organizer: Modular curves workshop II**

2022 **Reviewer: Swiss National Science Foundation**

Mar 2022 **Organizer: Modular curves workshop**

2021-2022 **Panel member: National Science Foundation**

2021- **Member: IT Oversight Committee**, *Department of Mathematics, MIT*

2021 **Reviewer: Austrian Science Fund**

2020- **Co-creator and administrator: researchseminars.org**
`https://researchseminars.org/`

July 2017 **Organizer: Conference Global Portuguese Mathematicians**
`https://mpm.math.tecnico.ulisboa.pt/`

July 2017 **Organizer: Sage Days 87**

2016- **Core developer: L-functions and Modular Forms Database**
`https://www.lmfdb.org/`

2011-2015 **Administrator and advisor: cSplash**, *`http://www.csplash.org/`*
Annual one-day lecture series for high school students taught by members the Courant Institute of NYU

Software (selected)

researchseminars.org, featured in Nature
`https://researchseminars.org/`

L-functions and Modular Forms Database
`https://www.lmfdb.org/`

Crystalline obstruction: computing upper bounds on the middle Picard number
`https://github.com/edgarcosta/crystalline_obstruction`

Controlled reduction: Computation of zeta functions of projective hypersurfaces
`https://github.com/edgarcosta/controlledreduction`
`https://github.com/edgarcosta/pycontrolledreduction`

Endomorphisms: Rigorous computation of the endomorphism ring of a Jacobian
`https://github.com/edgarcosta/endomorphisms`

Teaching Experience

Massachusetts Institute of Technology

Fall 2021 **Introduction to Algebraic Geometry**, *18.721*

Dartmouth College

Spring 2018 **Mathematical Cryptography**, *Mathematics 75*
Fall 2017 **Probability - Mathematics 20**
Fall 2017 **Differential Equations**, *Mathematics 23*
Spring 2017 **Differential Equations**, *Mathematics 23*
Fall 2016 **Calculus**, *Mathematics 3*
Spring 2016 **Probability**, *Mathematics 20*
Winter 2016 **Differential Equations**, *Mathematics 23*

New York University

Fall 2014 **Theory of Numbers**
Spring 2014 **Calculus 1**
Summer 2012 **Linear Algebra**

Instituto Superior Técnico

Spring 2010 **Complex Analysis and Differential Equations**
Spring 2009 **Complex Analysis and Differential Equations**
Fall 2008 **Complex Analysis and Differential Equations**