

AI for Mathematics and Year One at ICARM

Jeremy Avigad
August 5, 2026



Institute for Computer-Aided
Reasoning in Mathematics

Institute Overview

NSF Mathematical Science Research Institutes

The NSF maintains seven MSRIs across the US.

- National resources to support the mathematics research community.
- Intended to be “first and foremost a service to the mathematical sciences community as a whole.”
- Hold meetings, workshops, summer schools.
- Support postdocs, collaborative visits.



American Institute of Mathematics (AIM)
Pasadena, California
<http://www.aimath.org>
AIM fosters progress in all areas of mathematics through focused collaborative research.



Institute for Advanced Study (IAS)
Princeton, New Jersey
<https://www.ias.edu/math>
The Institute for Advanced Study is an independent, private institution dedicated entirely to the encouragement, support and patronage of learning through fundamental research and definitive scholarship across a wide range of fields.



Institute for Computer-Aided Reasoning in Mathematics (ICARM)
Pittsburgh, Pennsylvania
<https://icarm.io>
The mission of ICARM is to empower mathematicians to take advantage of new technologies for mathematical reasoning, including formal methods, automated reasoning, and machine learning, and to support cross-disciplinary collaboration to develop and explore their potential.



Institute for Computational and Experimental Research in Mathematics (ICERM)
Providence, Rhode Island
<http://icerm.brown.edu>
The mission of ICERM is to support and broaden the relationship between mathematics and computation and, specifically, to expand the use of computational and experimental methods in mathematics, to support theoretical advances related to computation, and to address problems posed by the existence and use of the computer through mathematical tools, research and innovation.



Institute for Mathematical and Statistical Innovation (IMSI)
Chicago, Illinois
<https://www.imsi.institute>
The essential mission of IMSI is to apply rigorous mathematics and statistics to urgent, complex scientific and societal problems, and to spur transformational change in the mathematical sciences and the mathematical sciences community. This mission is based on a vision with three fundamental elements: innovation, communication, and diversity.



Institute for Pure and Applied Mathematics (IPAM)
Los Angeles, California
<http://www.ipam.ucla.edu>
IPAM seeks to bring the full range of mathematical techniques to bear on the great scientific challenges of our time. We sponsor programs that bring together researchers from different disciplines or from different areas of mathematics, with the goal of sparking interdisciplinary collaboration that continues long after the IPAM program ends.

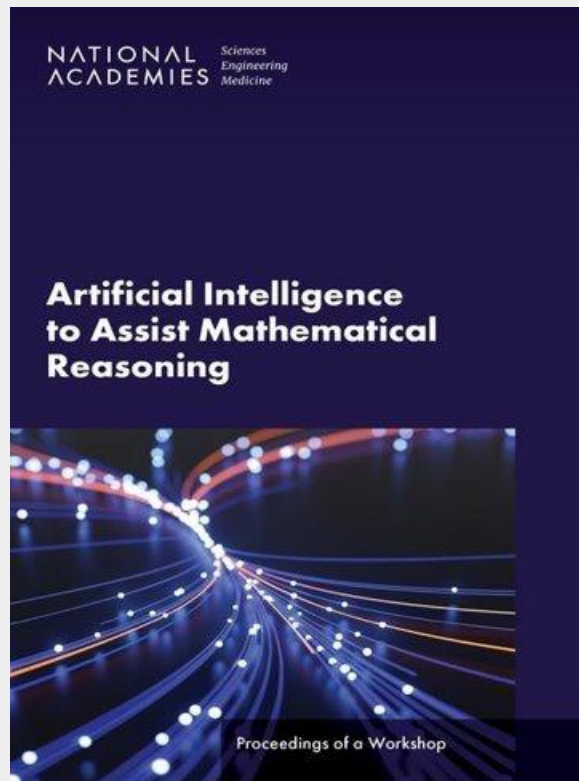


Simons Laufer Mathematical Sciences Institute (SLMath)
Berkeley, California
<https://simath.org>
The Simons Laufer Mathematical Sciences Institute (SLMath), formerly known as the Mathematical Sciences Research Institute (MSRI), exists to further mathematical research through broadly based programs in the mathematical sciences and closely related activities.

Motivation

In 2023, a workshop by the National Academies for Science, Engineering, and Medicine explored the promise of these technologies and the challenges that lie ahead.

The Institute for Computer-Aided Reasoning in Mathematics is designed to meet the challenges.



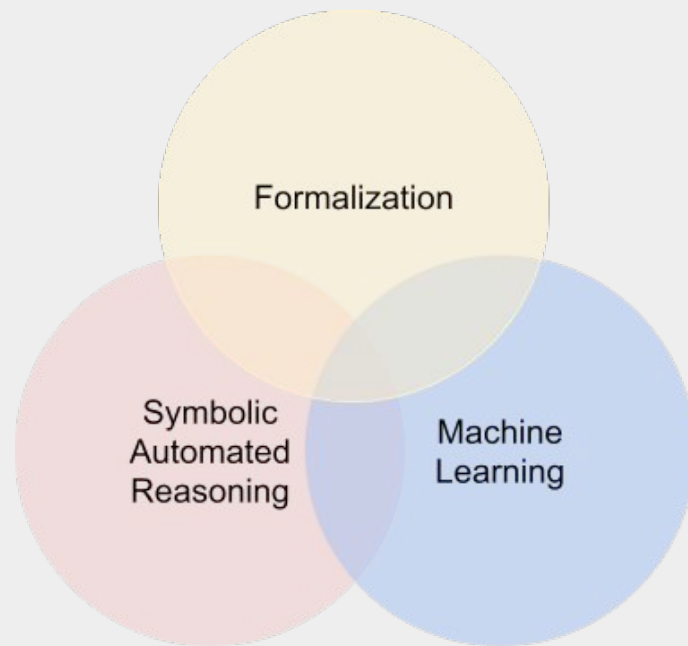
Computer-aided reasoning in mathematics

New technologies:

- interactive theorem proving and formalization
- automated reasoning and symbolic AI
- machine learning and neural AI

These are, collectively, “AI for Mathematics.”

All three come together in neurosymbolic theorem proving.



Mission

The mission of the *Institute for Computer-Aided Reasoning in Mathematics* is to:

- empower mathematicians to take advantage of new technologies for mathematical reasoning and keep mathematics central to everything we do;
- unite mathematicians of all kinds, computer scientists, students, and researchers to achieve that goal; and
- ensure that mathematics and the new technologies are accessible to everyone.

AI and reasoning technology are important for mathematics.

More to the point, mathematics is important for AI.

Empowering mathematicians

We will maintain a staff of *innovation engineers* who will:

- help mathematicians learn to use the technologies
- answer questions and provide technical support
- maintain documentation, tools, infrastructure, and other community resources
- serve as liaisons to computer science and industry
- carry out essential tasks that academics don't have time or incentives to do
- be community leaders in the use of technology
- gather resources and coordinate efforts.

Bringing us together

We will also provide:

- workshops
- summer schools
- collaborative visits
- an annual conference

These will build a community of students, researchers, mathematicians, computer scientists, engineers, and others to address the challenges together.

We need a combination of perspectives and expertise.

Improving access

AI and the digitization of mathematics can lead to greater democratization but can also lead to greater inequities.

A central goal of ICARM is to ensure that all communities have the resources they need to participate in mathematics and take advantage of the new technologies.

Our original proposal included a summer school for college students, a workshop for graduate students, and an after-school program for high school students to address this challenge head on.

This has been set aside in the pilot.

Summary

Conventional institute activities:

- Workshops
- Summer schools
- Conferences
- Postdocs

Novel institute activities:

- Innovation engineers (technical support)
- Curating resources (tutorials, tools, benchmarks, databases, documentation, etc.)

We hope to do more outreach one day.

Leadership and Staff

Leadership

- **Director:** Jeremy Avigad
- **Associate Director:** Matthew Ballard (University of South Carolina)
- **Assistant Directors:**
 - Marijn Heule (scientific activities)
 - Sean Welleck (scientific activities)
 - Prasad Tetali (operations)
 - Irina Gheorgiciuc (educational activities)
 - Michael Young (outreach)
 - Aris Winger (Georgia Gwinnett College, outreach)

Staff

Administrative assistance:

- Senior Administrative Coordinator: Jennifer Agnew
- Business Manager, Grants Manager: through the provost's office

Innovation engineers:

- Blake Jackson
- David Renshaw
- Aayush Rajasekaran

Advisory Boards

Advisory boards

We have guidance and oversight from:

- **A scientific advisory board:** oversight of scientific direction and activities
- **An educational advisory board:** oversight of educational direction and activities
- **A strategic advisory board:** advice on administration, management, public relations, foundations, corporations
- **University oversight board:** fiscal and management oversight

Scientific Advisory Board

- **Jennifer Balakrishnan**, Professor, Department of Mathematics and Statistics, Boston University
- **François Chardon**, Technical Staff, Axiom
- **Johan Commelin**, Director, Mathlib Initiative, and Assistant Professor, Department of Mathematics, Utrecht University
- **Sébastien Gouëzel**, Research Director, Centre national de la recherche scientifique (CNRS)
- **Emily Riehl**, Kelly Miller Professor of Mathematics, Johns Hopkins University
- **Radmila Sazdanovic**, Associate Professor, Department of Mathematics, North Carolina State University
- **Adam Zolt Wagner**, Research Scientist, Google DeepMind

Educational Advisory Board

- **Chris Sangwin**, Professor of Mathematics Education, University of Edinburgh
- **Keith Weber**, Distinguished Professor and Chair, Department of Teaching and Learning, Rutgers

Strategic Advisory Board

- **Tudor Achim**, Co-Founder and CEO, Harmonic
- **Leonardo de Moura**, Senior Principal Applied Scientist, Automated Reasoning Group, Amazon Web Services; Chief Architect and Co-Founder, Lean Focused Research Organization
- **Pushmeet Kohli**, Vice President of Science and Strategic Initiatives, Google DeepMind
- **Cindy Lawrence**, Executive Director and CEO, National Museum of Mathematics
- **Jason Rute**, AI Scientist, Mistral AI
- **Ravi Vakil**, Robert Grimmett Professor of Mathematics, Stanford University and President, American Mathematical Society
- **Melanie Matchett Wood**, William Caspar Graustein Professor of Mathematics, Harvard University

Infrastructure and Space

Information technology

- Our web pages are at icarm.io.
- You can register, join a mailing list, propose a workshop or visit, etc.
- We have a semi-private Zulip social media server.
- Arjen van Lith and Marijn Heule designed our logos.



ICARM

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— NSF MATHEMATICAL SCIENCES RESEARCH INSTITUTE · CARNEGIE MELLON UNIVERSITY

Institute for Computer-Aided Reasoning in Mathematics

ICARM supports the use of new technologies for computer-aided reasoning and discovery in mathematics. The institute is hosted by [Carnegie Mellon University](#) on its campus in Pittsburgh.

- Formal methods and proof assistants
- Automated reasoning and symbolic AI
- Machine learning and neural AI

[Join our e-mail list](#) → [About the institute](#)

Robert Mehrabian Collaborative Innovation Center · CMU

NEWS

[All news](#) →

— JUL 24, 2026

ICARM endorses the Leiden Declaration

We endorse the Leiden Declaration as an important first step in helping the mathematics community grapple with the use of AI.

— APR 24, 2026

Milestones workshop frames AI progress in mathematics

ICARM and Principia Labs convened mathematicians and AI researchers in San Francisco to define meaningful milestones for autonomous mathematics research.

— APR 15, 2026

ICARM mentioned in Quanta

ICARM director Jeremy Avigad is quoted in Quanta Magazine's survey of AI's arrival in mathematical research.

Space

We have space in the *Collaborative Innovation Center*:

- Offices for staff.
- Small meeting rooms.
- Common area.
- Workshop space for 35-40 people (in progress).

We will rely on campus space for larger meetings.





First-Year Meetings and Workshops

NSF AIMing PI meeting (April 2-3)

This was the first meeting of members of the NSF AI for Mathematical Reasoning (AIMing) grant program.

It was a 2-day meeting, with 35 participants.

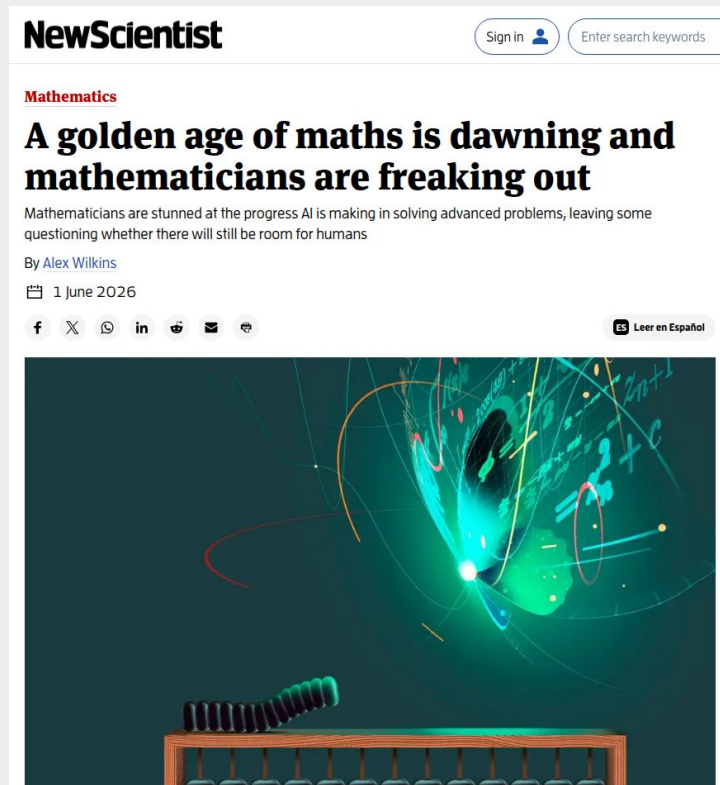
It was a great first meeting: we learned how to

- Reserve an appropriate room
- Set up a hotel link
- Deal with caterers
- Handle other logistics

Milestones of Autonomous Mathematics Research (April 13-15)

- Organizers:
 - Elliot Glazer
 - Alex Kontorovich
 - Daniel Litt
 - Jacob Tsimerman
 - Ravi Vakil
- Joint with Principia Labs, organized on short notice
- Held in San Francisco (PL sponsored it)
- 37 in-person participants, including corporate labs (but mostly mathematicians)

Glazer is coordinating with organizers to prepare a document that compiles the results of the discussion.



Algebraic Geometry and Machine Learning (June 22-26)

- Organizers:
 - Matt Baker (Professor, Mathematics, Georgia Tech)
 - Jennifer Balakrishnan (Professor, Mathematics, Boston University)
 - François Charton (Technical Staff, Axiom)
 - Amaury Hayat (professor, Mathematics, Ecole des Ponts)
 - Andrew Sutherland (Senior Research Scientist, Mathematics, MIT)
- Topic: use of machine learning for discovery in algebraic geometry
- 39 participants
- AIM-style project-based workshop
- Discussions about AI at the end



1. **Inverse Galois:** Build a verified database of smooth cubic surfaces over $\mathbb{Q}$ that realize specified subgroups of $W(E_6)$ as the Galois action on their 27 lines, together with invariants such as orbit data and Frobenius profiles.
2. **How to Train Your Model:** Investigate, as a starting point, whether a machine-learning model can be trained to infer the mathematical definition of intersection number.
3. **Planar Central Configurations:** Improve and clarify computer-assisted algorithms for classifying equal-mass planar central configurations, using symmetry, better coordinates, rigorous interval methods, and structural arguments to make the enumeration more efficient and human-readable.
4. **Hartshorne's Conjecture:** Study Hartshorne's conjecture asking whether every smooth projective m -fold $X \subset \mathbb{P}_{\mathbb{C}}^n$ with $m > 2n/3$ must be a scheme-theoretic complete intersection.
5. **Cross-Ratio Degrees:** Determine from the combinatorics of $n - 3$ four-element subsets of $[n]$ the number of configurations of n labeled points on $\mathbb{P}^1$ with prescribed generic cross-ratios.
6. **Elliptic Curves of Large Rank:** Search for elliptic curves of rank at least 12 with unusually small conductor, discriminant, or height.
7. **Ehrhart Theory of Matroids:** Develop a dictionary between Ehrhart theory and matroid theory by testing which properties of h^* -vectors, such as nonnegativity and Stanley-type inequalities, transfer from lattice polytopes to matroids.
8. **Completely Decomposable Jacobians:** Determine which genera admit curves whose Jacobians are isogenous to products of elliptic curves, seeking new examples as well as general constructions or obstructions.
9. **Ceresa Cycles:** Are there non-hyperelliptic curves of arbitrarily large genus whose Ceresa cycle $[X] - [X^-]$ vanishes in $CH_1(\text{Jac}(X))_{\mathbb{Q}}$?
10. **Brill–Noether Theory for Graphs:** Establish Brill–Noether existence and gonality bounds for divisors on graphs, ideally through purely combinatorial proofs rather than specialization from algebraic curves.

Summer School on Formalization of Mathematics (July 7-17)

- Organizers:
 - Bhavik Mehta (Postdoc, Mathematics, Imperial College)
 - Robert Lewis (Lecturer, Computer Science, Brown University)
- Topic: formalization of mathematics in Lean, metaprogramming
- 2 organizers, 37 students, 6 teaching assistants
- Has already resulted in two new pull requests to Mathlib
- Lectures + exercise sessions the first week
- Lectures + projects the second week



Offsite Events

Lean for PDEs (October 6-9, 2025)

Organizers:

- Remy Degenne
- Michael Rothgang

Gave a series of three lectures and collaborated during the week.



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[Quick Links](#)



Lean for PDEs, an ICARM & SLMath collaboration

1180@slmath.org

October 6th, 2025 - October 9th, 2025

Registration Deadline	October 9th, 2025
To Apply For Funding You Must Register By	October 3rd, 2025
Location	SLMath: EISENBUD AUDITORIUM, BAKER BOARD ROOM, COMMONS ROOM, ATRIUM, ONLINE/VIRTUAL

Registration deadline has passed.

Joint Mathematics Meetings (January 4-7)

- Booth in the Exposition Hall
- Tutorial: finding combinatorial objects with SAT solvers
- ICARM recognized in Geordie Williamson's plenary talk (thousands in attendance)



Contributions to other meetings

- Assistance at AIM AI + Number Theory (David, Blake, May 27-30)
- AlphaEvolve talk / tutorial at Combinatorics at the Confluence (Adam Wagner, July 22)
- “Mathematics in Lean” special session at the International Congress on Mathematical Software in Toronto (Matt, July 23).
- REUF at AIM (Jeremy, July 27-31)

First-Year Activities

IE activities

- Assistance with sphere packing formalization
- Creating matroid database
- Creating elliptic curve rank leaderboard
- Creating equational theories 677 database
- Help with JMM booth (including great videos)
- Help with AGML workshop
- Help with formalization summer school
- Help with SACNAS proposal
- Help with AI for math Aarhus
- Help with AI + Number Theory at AIM

Zulip

- Used internally for admin
- Used for advisory board discussion
- Used by meeting organizers
- Used by meeting participants
- Hosting public First Proof discussion
- Hosting public milestones discussion
- Hosting private expMath discussion

The screenshot displays the First Proof website with a dark theme. At the top, the 'FIRST PROOF' logo is on the left, and navigation links for 'Home', 'Benchmark', and 'Community Experiment' are on the right. The 'MISSION' section describes the project's goal of providing independent, transparent, and rigorous engagement with AI in research mathematics. The 'ANNOUNCEMENTS' section lists two events: 'Second Batch results published here and presented at a CMSA webinar at 1pm ET.' on June 10, 2026, and 'Second Batch announced: formal benchmark and community round planned for March–June 2026. Details' on March 14, 2026. The 'ACKNOWLEDGMENTS' section states that the project is supported by various institutions and funders, categorized into 'ACADEMIA' and 'FOUNDATIONS'. The 'ACADEMIA' section includes logos for the Simons Institute, Harvard University Center of Mathematical Sciences and Applications, and ICARM. The 'FOUNDATIONS' section includes logos for the Survival & Flourishing Fund, a geometric logo, and Google.org.

FIRST PROOF

Home Benchmark Community Experiment

MISSION

First Proof provides independent, transparent, and rigorous engagement with the evolving capabilities of AI in research mathematics. We offer clarity to the mathematical community and to the public so as to ground conversations about the role of AI tools.

ANNOUNCEMENTS

June 10, 2026 Second Batch results published [here](#) and presented at a [CMSA webinar](#) at 1pm ET.

March 14, 2026 Second Batch announced: formal benchmark and community round planned for March–June 2026. [Details](#)

ACKNOWLEDGMENTS

The First Proof Project is made possible by the generous support of the following institutions and funders.

ACADEMIA

FOUNDATIONS

Can we find a finite magma M that satisfies

$$\forall x y : M, \quad x = y \diamond (x \diamond ((y \diamond x) \diamond y)) \quad (\text{Equation 677})$$

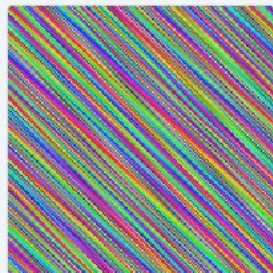
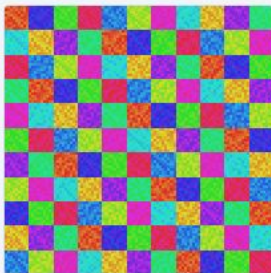
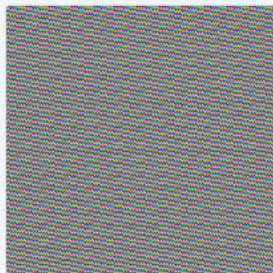
but does **not** satisfy

$$\forall x : M, \quad x = ((x \diamond x) \diamond x) \diamond x ? \quad (\text{Equation 255})$$

This site collects finite magmas that satisfy [Equation 677](#). So far, every known example also satisfies Equation 255 — finding one that does *not* (or proving none exists) is the main open question remaining from the [Equational Theories Project](#).

The canonicalization and database are based on [memoryleak47/eq677](#).

[Browse the database](#) →



(random magmas from the database)

Can we find **small** elliptic curves of **high rank**?

Inspired by [Dujella's rank tables](#), this site tracks elliptic curves $E/\mathbb{Q}$ of high [Mordell–Weil rank](#) relative to their size — measured by naive height, Faltings height, or [conductor](#).

Every entry is backed by an explicit list of rational points. We certify a **rank lower bound** without computing the exact rank: each point is checked to lie on the curve, and their Néron–Tate height-pairing matrix is checked to be positive definite — so the points are independent in $E(\mathbb{Q})$, proving rank $\geq$ the number of points. Supplying the curve's bad primes additionally records its conductor, minimal discriminant, and Faltings height.

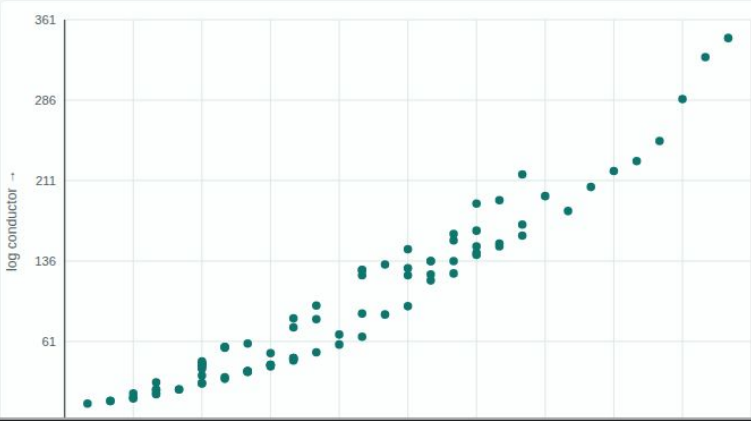
[Download the database \(JSON\)](#) | [Browse all curves as a table](#) → | [See recent activity](#) →

Plots

Each dot is a curve — click one for its witness. The frontier is down and to the right: high rank, small height/conductor.

log conductor vs rank

Natural log of the conductor $N = \prod_p p^{f_p}$ over bad primes. Recorded when a submission supplies the curve's bad primes.



[← all enumerations](#)

n10r04

Matroids on 10 elements of rank 4. [manifest.json](#)

n	10
r	4
line length	$C(10,4) = 210$
chunks	49
matroids stored	4,886,380,924
total size	657.09 MiB

Tooling for downloading and reading the chunks below is available at [matroid-database-client](#).

file	index range	count	size	uploaded (UTC)
000000000-0099999999.sz.xz	0 – 99,999,999	100,000,000	36.59 MiB	2026-05-20 20:23:34
0100000000-0199999999.sz.xz	100,000,000 – 199,999,999	100,000,000	26.92 MiB	2026-05-20 20:23:30
0200000000-0299999999.sz.xz	200,000,000 – 299,999,999	100,000,000	23.15 MiB	2026-05-20 20:23:29
0300000000-0399999999.sz.xz	300,000,000 – 399,999,999	100,000,000	19.64 MiB	2026-05-20 20:23:30
0400000000-0499999999.sz.xz	400,000,000 – 499,999,999	100,000,000	15.23 MiB	2026-05-20 20:23:33
0500000000-0599999999.sz.xz	500,000,000 – 599,999,999	100,000,000	16.75 MiB	2026-05-20 20:23:35
0600000000-0699999999.sz.xz	600,000,000 – 699,999,999	100,000,000	17.81 MiB	2026-05-20 20:23:35
0700000000-0799999999.sz.xz	700,000,000 – 799,999,999	100,000,000	20.55 MiB	2026-05-20 20:23:39
0800000000-0899999999.sz.xz	800,000,000 – 899,999,999	100,000,000	20.02 MiB	2026-05-20 20:23:39
0900000000-0999999999.sz.xz	900,000,000 – 999,999,999	100,000,000	18.74 MiB	2026-05-20 20:23:39
1000000000-1099999999.sz.xz	1,000,000,000 – 1,099,999,999	100,000,000	20.02 MiB	2026-05-20 20:23:42
1100000000-1199999999.sz.xz	1,100,000,000 – 1,199,999,999	100,000,000	16.98 MiB	2026-05-20 20:23:43
1200000000-1299999999.sz.xz	1,200,000,000 – 1,299,999,999	100,000,000	16.40 MiB	2026-05-20 20:23:43
1300000000-1399999999.sz.xz	1,300,000,000 – 1,399,999,999	100,000,000	14.59 MiB	2026-05-20 20:23:42
1400000000-1499999999.sz.xz	1,400,000,000 – 1,499,999,999	100,000,000	13.69 MiB	2026-05-20 20:23:46
1500000000-1599999999.sz.xz	1,500,000,000 – 1,599,999,999	100,000,000	13.77 MiB	2026-05-20 20:23:46
1600000000-1699999999.sz.xz	1,600,000,000 – 1,699,999,999	100,000,000	15.39 MiB	2026-05-20 20:23:47
1700000000-1799999999.sz.xz	1,700,000,000 – 1,799,999,999	100,000,000	14.10 MiB	2026-05-20 20:23:46
1800000000-1899999999.sz.xz	1,800,000,000 – 1,899,999,999	100,000,000	13.95 MiB	2026-05-20 20:23:50
1900000000-1999999999.sz.xz	1,900,000,000 – 1,999,999,999	100,000,000	11.71 MiB	2026-05-20 20:23:49

Fix a modulus N and look for a large set $A \subseteq \mathbb{Z}/N\mathbb{Z}$ containing *no nontrivial solutions* to

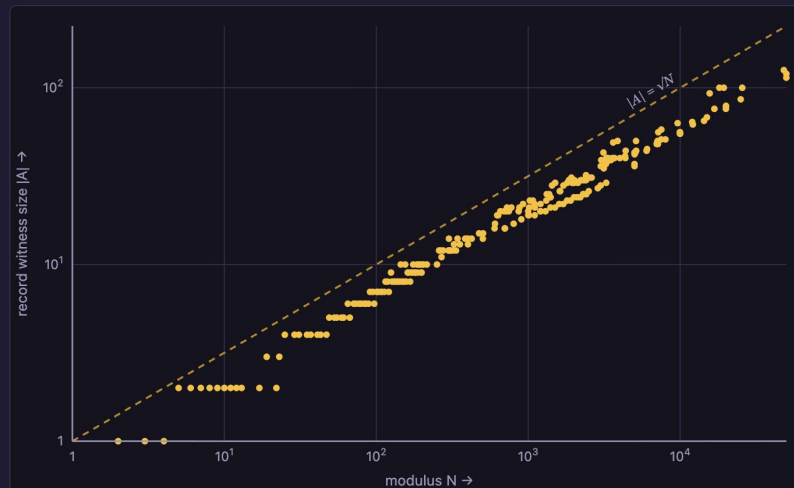
$$a + 3b \equiv 2c + 2d \pmod{N}$$

with $a, b, c, d \in A$. A solution is *trivial* when $a = b = c = d$.

The best known constructions achieve $|A| = \Theta(\sqrt{N})$, while the conjecture is that $|A| = N^{1-o(1)}$ is possible. The challenge: find a witness with score $|A|/\sqrt{N} > 1$.

record size $|A|$

exponent $\log |A|/\log N$



Each dot is the largest known witness for its modulus. A dot above the dashed line beats $\sqrt{N}$.

[Browse all witnesses →](#) · [Recent activity →](#)

[Download all records \(JSON\) ↓](#)

Publicity

Institute for Advanced Study. Like Tao, Venkatesh is a recipient of the Fields Medal, math's most prestigious prize. Both agree that AI's impact will be significant, but Venkatesh is more cautious about it: "There are valuable things in our culture which we should try to keep," he said.

Some mathematicians are now leaving academia to work at big tech firms, like OpenAI and Google, or to join math-focused AI startups such as [Harmonic](#), [Logical Intelligence](#), [Axiom Math](#), and [Math Inc.](#) "One reason there is so much interest in AI for mathematics in the corporate world is that people are recognizing that the key to general intelligence is combining the insights you get from machine learning and the precision you get from mathematics," said [Jeremy Avigad](#), the director of the Institute for Computer-Aided Reasoning in Mathematics at Carnegie Mellon University.

[nature](#) > [news](#) > article

NEWS | 12 June 2026

Humans outperform AI at this highly rigorous mathematics test

A new benchmark pitting AI against previously unseen maths problems still fall short of top human expertise.

By [Davide Castelvecchi](#)



RELATED



AI cracks 80-year-old mathematics challenge – researchers are astonished

This time, First Proof ran the test itself: the team asked the models to solve problems in an entirely autonomous way, and had a group of 30 mathematicians vet the answers. “The organizers have clearly thought through the second batch more carefully to make it more controlled and systematic,” says mathematician Jeremy Avigad, who heads the Institute for Computer-Aided Reasoning in Mathematics at Carnegie Mellon University in Pittsburgh, Pennsylvania.

Another rule was that the participating models had to be publicly available. This meant that Google’s Aletheia – a system designed specifically for solving maths problems – and the full, unreleased version of Claude Mythos, a model made by Anthropic in San Francisco, California, could not be used. OpenAI was the only big company that participated, with its model ChatGPT 5.5 Pro.

Plans for the Second Year

Second-year meetings

- First Proof: Third Batch (October 8-9)
- Formalization for Physics (November 4-6)
- Formalization for Statistics (likely in the Spring)
- Matroids and Computation (likely in the Spring)
- Conference on Computer-Aided Reasoning (summer 2027)
- Bootcamp on AI and Algebraic Geometry (summer 2027)

Also:

- Several collaborative visits
- Visiting faculty member
- Postdoc
- Hopefully, a workshop on AI and mathematics education

Offsite events in the second year

- SACNAS tutorials (October 29 or so)
 - Part of a larger multicultural STEM conference.
- JMM tutorial (January 2027)
 - “Formalization, autoformalization, and you”

Prospective IE activities

- Continue helping to prepare workshops and summer schools.
- Create tutorials.
- Film lectures, create videos.
- We have been asked to take over LeanSearch.
- We could do similar things for various premise selection tools.
- François Charton suggested maintaining a Python machine-learning-for-math library.
- Create Zulip “tools” folder for help / discussion of specific tools.
- Create volunteer database to match volunteers with people who need them.
- Hold office hours?

Worrying about AI for Mathematics

An OpenAI model has disproved a central conjecture in discrete geometry

[Read the proof ↗](#)

[Read the companion remarks ↗](#)



August 1, 2026 Publication

Ten advances in mathematics and theoretical computer science

[Read the paper ↗](#)

[Read the reasoning walkthroughs ↗](#)



AI Will Be Top of Mind at ICM, Math's Biggest Conference

The International Congress of Mathematicians, coming to Philadelphia this summer, includes panels and talks about artificial intelligence and the humanity of the field.



By Yen Duong
May 4, 2026



Things to worry about

AI at large:

- Concerns about reliability, explainability, alignment, access
- Economic and social concerns

Keeping mathematics in the loop is part of the solution.

AI in mathematics:

- Changes to the discipline: what's left for us?
- Changes to the practice of mathematics
- Ceding mathematical research to big tech
- Access to resources for mathematicians
- Engagement in mathematics in the public at large

Anxiety over AI

Among mathematicians I have spoken to, reactions to AI range from strong optimism to strong pessimism.

Among students and early-career researchers, the distribution skews toward pessimism.

To those worried about their careers and their future, cheerful optimism about AI is even hurtful.

What is AI for Mathematics?

What is AI for mathematics?

Answer #1 (not my favorite):

- Using LLMs and foundational models to prove theorems.

Concerns:

- Anyone can do that; why do we need mathematicians?
- Foundation models are expensive; current subscriptions are subsidized to lock in users.
- Excessive computation damages the environment.
- Will mathematics become like a lab science, where practitioners need to raise money to get the best results?
- Will this restrict access to mathematics?
- Will LLMs replace the kind of deep thought and engagement that mathematics traditionally required?
- Will the resulting mathematics have the same aesthetic appeal?

What is AI for mathematics?

Formalization and Proof Assistants

- Developing well-designed libraries and formal artifacts
- Developing automation
- Developing new tools and methods for collaboration
- Developing new means of interaction

Symbolic AI

- Using SAT solvers
- Using SMT solvers, constraint solvers
- Using first-order provers
- Developing optimization techniques

Machine learning

- Mining mathematical data
- Searching for mathematical objects of interest
- Using PINNs
- Developing optimization techniques
- Proving formal and informal theorems

Neurosymbolic methods

- Proving theorems
- Discovering patterns
- Finding mathematical objects
- Interpreting data

What is AI for mathematics?

It is not enough to think of mathematicians as **consumers** of AI.

We need to **contribute** to the use of AI to solve theoretical and practical problems:

- New methods for using AI
- More efficient, scalable reasoning
- New applications
- Leveraging deep expertise and understanding

Thinking about mathematics and AI

Mathematics is part of the human experience.

- It's beautiful.
- It's useful.

The two can't be separated.

AI is a technology. There is no sense to seeing us in competition with it.

The only questions are:

- How do we want to use it?
- How should we use it?

The value of mathematics

Since ancient times, we have developed beautifully creative ways to solve hard problems and carry out complex chains of reasoning with limited computational resources, namely, our minds.

It's hard to believe that LLMs are the most efficient way to mechanize mathematical reasoning.

Mathematicians can help us learn how to use AI more efficiently.

The value of mathematics

We know how to

- ask questions,
- come up with abstractions,
- build theory,
- explore concepts, and
- push the boundaries of what we can understand.

We are disciplined, and we have a culture of engaging with problems deeply and not letting them go.

We should be leaders in the use of AI, showing the world what AI can do and how it can do it.

Keeping mathematics strong

Challenge: Few mathematicians currently have expertise in AI beyond prompting ChatGPT.

Solutions:

- A new *Journal of AI for Mathematical Discovery* will incentivize and support work in the area.
- We need more workshops like this one. (Thank you KIAS.)
- We will do our best at ICARM. (Please propose a workshop, get involved.)

Most importantly, however...

Keeping mathematics strong

Those of us who are more settled in our careers need to work with students and early-career researchers to figure out what mathematics should be in the age of AI.

Key messages:

- We are committed to mathematics.
- We know that the future depends on you.
- We need to work together to face the challenges ahead.

Closing Thoughts

These are interesting times.

Let's make the most of them.



**Institute for Computer-Aided
Reasoning in Mathematics**