

Preparing Mathematics Departments for AI-Assisted Research and Formalization

A Proposal for Resource-Limited Mid-Scale Public R1 Universities

Christopher L. Rogers, Ph.D.

hoalg.net/chrisrogers

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Background

In July 2026, I was invited by the National Academy of Sciences (NAS) to participate in a meeting held in Washington, D.C., on "Emerging Issues in AI and the Organization of Mathematical Knowledge." Its approximately 70 participants represented a diverse range of stakeholders: mathematicians, AI-industry executives, software developers, philanthropists, and program directors from DARPA, NSA, and NSF.

That meeting provides the primary context for this document. However, the focus here is specifically on mathematics departments at mid-scale public R1 universities with limited resources. The issues I address are scientific, epistemological, educational, and institutional.

AI and formalization are already having a growing impact on mathematics as a profession. We can expect this transformation to continue and possibly accelerate over the next five years.

The pace and eventual scale of change remain uncertain. I therefore attempt to base my forecast on reasonable standing assumptions, and keep this separate from a more accelerated scenario and a worst-case institutional outcome which I discuss at the end of the document.

The emerging changes will affect tenured faculty in all mathematics departments in at least four key ways:

1. what we do (the things we research);
2. how we do it;
3. how we train our research students; and
4. how we measure and produce our research - including deliverables, merit, and promotion.

Clearly there is interdependence among these, e.g., changes in research practice impact graduate training, and both of these eventually affect what departments recognize as scholarly contribution.

Forecasting scenarios

In more detail, here are my *standing assumptions* concerning the next five years:

- A. AI systems and formal proof tools will be adopted increasingly, but not necessarily uniformly across mathematics.
- B. Access to frontier models and computation infrastructure will positively influence research productivity.

- C. A working knowledge of formalization and familiarity with proof assistants, such as Lean, will become desired skills for careers in AI systems, cybersecurity, and related areas

Under a more *accelerated scenario*, these changes could occur more quickly in those areas of mathematical research which are particularly well suited to formalization.

My proposed *worst-case scenario* is institutional: a mathematics department that does not evolve their relevant research and training capacity in response to (A), (B), and (C) could gradually lose those functions to computer science or centralized AI programs and become predominantly an instructional department focused on service teaching.

In the next four next sections, I describe how standing assumptions (A)-(C) will impact the areas (1)-(4) of departmental activity identified above, and propose actions that a department can take to mitigate the negatives and take advantage of the positives.

1. Impact on what we do

Certain fields of mathematics will be affected earlier or more visibly than others. From the available data, including recent successes in AI-assisted research and the current development of the Lean mathlib library, such fields could include certain areas of:

- combinatorics and graph theory;
- finite-dimensional linear algebra;
- number theory;
- analysis; and
- discrete geometry and classical algebraic geometry.

I wish to emphasize that "exposed" does not mean "obsolete." In many cases, these may be fields in which AI assistance creates the greatest opportunities for new research.

Forecasts of this kind should become sharper over the next one or two years. Regardless of the outcome, departments should prepare to use this data to inform future hiring priorities, graduate student mentoring, and course offerings. Departments should also explore resources that would help established faculty redirect parts of their research programs in response to AI's impact, when appropriate.

A growing share of federal research funding is being directed toward AI and quantum-computation. This creates adjacent opportunities for pure mathematics in addition to the conventional pure-mathematics funding. AI development has and will have a significant intersection with formalization, and formalization is emerging as the way to make AI-assisted mathematics more reliable. In effect, this may become a new form of "broader impacts" for pure mathematics.

Departments should maintain a shared list of relevant calls for proposals, funding opportunities and work collaboratively across subdisciplines on grant proposals.

2. Impact on how we do mathematics

Faculty access to frontier models and appropriate computational infrastructure could accelerate research productivity and increase deliverable outputs. Even if a faculty member does not use AI in

the exploratory phase of their work, current models can assist with formalizing selected arguments in the Lean proof assistant and identifying errors.

As a brief example, I recently attempted to autoformalize in Lean existing arXiv preprints authored by faculty in my own department. In more than one case, this led to the model identifying plausible mathematical errors that warranted human examination. To be clear, autoformalization is not itself verification: confirming semantic alignment will always require a mathematical review by a human expert.

Unfortunately, at many mid-scale public institutions, existing university-wide AI offerings do not yet provide the model access, API access, or computation infrastructure required for research-grade mathematical work. Departments should explore opportunities for collective or department-wide access to frontier models and computing resources. These include grants from federal funding sources as well as from AI laboratories. Several of the latter provide funding opportunities with quick turnaround that provide research credits or compute time.

In contrast, researchers at well-resourced institutions are already incorporating these tools into their work. Departments without comparable access face a competitive disadvantage, and risk having their research programs getting scooped.

Along with funding and infrastructure, departments should consider seminars or workshops on Lean, the use of large language models in mathematical research, and deterministic verification tools such as those developed by Axiom Math.

Furthermore, mathematics departments should also begin sustained discussions with computer science and engineering. Software developers working on formal verification need substantial knowledge of proof and axiomatic reasoning, while mathematicians using these systems need greater familiarity with coding and software development. These complementary needs create natural opportunities for research collaboration and interdisciplinary funding.

3. Impact on training research students

In contrast to what we hear now in popular media, the career outlook for mathematics Ph.D.s with knowledge in LLM-assisted formalization could be strong over the next five years, particularly because of the focus on formal verification in AI systems and cybersecurity. In short, formal verification is the way to keep software secure from increasingly sophisticated AI-based adversaries.

To state the obvious: this is an opportunity, not a guarantee. Nevertheless, departments should accurately communicate both opportunities and uncertainties regarding the impact of AI on research careers in mathematics, and STEM careers more broadly.

Graduate students will need access to frontier models and computational resources as well as training, if such tools become standard in mathematical research. One practical first step would be a one-credit course or structured seminar on AI-assisted mathematical research and formalization in Lean. A basic expectation of "Lean literacy" could eventually play a role analogous to the foreign-language requirements, such as French or German, that were once commonplace requirements in mathematics Ph.D. programs.

4. Impact on deliverables, merit, and promotion

The conventional publication model in mathematics is likely to experience disruption over the next several years. Rapid growth in AI-assisted submissions could exacerbate known editorial issues in mathematical publishing. In particular, pure mathematics faculty could experience longer delays in receiving referee reports and editorial decisions. Departments should consider how such delays will affect merit evaluations, including tenure and promotion.

Publication standards are also likely to change. Short papers containing incremental results may become harder to publish, in contrast with a complete solution to a significant open problem. Furthermore, greater value might be placed on the conceptual content of results. Historically, the research output of departments at mid-sized public institutions has taken the form of shorter and/or more niche specialized papers. Such departments may require a larger adjustment to these new publishing standards.

In response to an increased volume of submissions, it is possible that journals will eventually require formal verification certificates for AI-assisted results. Such certificates could even become routine for all submissions in certain fields, whether AI-assisted or otherwise.

The practice of mathematical research itself may also involve more effort towards development of computational infrastructure. This work could include software development and contributions to formalization libraries such as Lean's mathlib. Pure mathematicians may begin to work like computational physicists did in the early 1990s, which required expertise in hardware and software along with the underlying science being investigated.

Activities like development of infrastructure blur the line between research and service to the discipline, and may be difficult to assess via traditional evaluation systems centered on papers, talks, and grants. Departments should consider sooner rather than later how these contributions should be properly assessed and evaluated.

Institutional constraints at resource-limited universities

The developments discussed so far are making an impact throughout the profession, but they are especially consequential for universities with limited resources and significant budgetary constraints.

In particular, mathematics departments at mid-scale public institutions should not assume that central university resources will arrive on the timetable required by the discipline. To remain competitive, such a department may need to pursue its own funding and computational infrastructure. Along with that, new positions may be needed such as staff scientists, postdoctoral researchers with expertise in AI, and work-study students with strong coding experience.

The bottom line: effective adaptation will likely require initiative from within the department. Departments will need to generate their own critical mass. Crucially, rising teaching loads, increasing administrative work, and declining time for traditional research make adaptation more difficult for individual faculty.

Furthermore, many such departments have relatively senior faculty that are strongly "siloed" in their individual research practices, and which have limited experience in organizing collective change.

While these are familiar ordinary institutional constraints, within the present context, they make coordinated action even more important.

A worst-case scenario

What I now describe below is not inevitable, nor is it offered as prediction. Rather, I posit that it is a plausible worst-case scenario for departments that remain passive while research practices and student career pathways change around them.

Over the next five or more years, universities are likely to recognize that AI and formal verification are important sources of STEM research and employment. If a mathematics department has not developed relevant expertise by the time substantial institutional investments are made, those investments may flow primarily to computer science or engineering. Research and research training in mathematically intensive AI could then migrate outside mathematics, leaving the mathematics department with a predominantly basic instructional role.

In other words, the risk is that mathematics departments could lose their hold on traditional and new research areas grounded in mathematical reasoning if they are absent during their evolution and development.

A department-level response

I included the above worst-care scenario as a clearly marked danger zone in order to help identify actions that can steer away from it and near-by scenarios. Because the trajectory remains uncertain, an appropriate response should be staged, collaborative, and evidence-driven.

A standing or ad hoc committee on mathematical research and AI would clearly provide a practical starting point.

Its scope should combine elements of research strategy, faculty development, graduate policy, faculty evaluation policy, and computing and equipment planning. Its central task would be to analyze the four areas I presented above and propose both responses to the risks and ways to take advantage of the opportunities.

A reasonable list of duties for the committee could include exploring the following:

1. assessing faculty and graduate student access to frontier models, proof assistants, and other computation infrastructure,
2. organizing a department Lean and AI-assisted research seminar,
3. proposing a one-credit required graduate course building on the above seminar;
4. initiating a formal collaboration with groups in computer science,
5. maintaining an updating a department wide list of funding opportunities and requests for proposals,
6. recommendation of how faculty infrastructure work should be evaluated for merit,
7. Identifying trends that may impact future hiring, mentoring, and course offerings,

8. providing updates to the department that distinguish evidence-based observed developments in AI assisted math research, in contrast with press releases, articles in popular media, etc.

Ideally, such a committee should provide the department with enough shared expertise to make deliberate, informed, and flexible choices, as well as support faculty and students interested in engaging with AI-assisted research.

Conclusion

The effects of AI and formalization on mathematical research, graduate education, and research deliverables call for a collective department-wide response.

How we practice mathematics has already changed, but what mathematics is has not. The career outlook for mathematically trained researchers may be stronger than the current rhetoric suggests, particularly in areas that will depend on formal verification of AI-based systems.

The argument for acting now does not depend on accepting the worst case scenario. The cost of initial preparation is modest when compared with both potential opportunities and institutional risks of inaction. A mathematics department that takes ownership of its evolution can strengthen its research mission and at the same time improve its students' career prospects. Such a department can indeed remain an active participant in determining how mathematics is practiced at its home institution and beyond.