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There are moments in the life of a mathematician when one realizes that the rules of the game may have changed without anyone announcing it. For me, one such moment came in early August at IWOTA 2026, held at Laval University. One of the dominant topics of the conference was the solution of the two-decade-old Crouzeix conjecture. Many prominent mathematicians had tried to settle this conjecture over the years. Their efforts had not been successful, but they had produced several beautiful new results that were interesting in their own right. Indeed, I once said that I hoped the conjecture would not be settled too soon, so that we could continue to witness interesting discoveries in matrix analysis and operator theory. And then, quite suddenly, using AI, the conjecture was settled by a colleague who was not even a member of the analysis community at large. A second proof was presented at IWOTA at the same time. My point here is not to discuss the priority, validity, or relative merits of these proofs. What caught my attention was something more fundamental: the possibility of obtaining a major mathematical breakthrough with the assistance of AI.

We are often told that AI has absorbed the entirety of the mathematical literature (books, papers, and publications accumulated in the major libraries around the world) and that its virtually unlimited memory allows it to retain this vast body of knowledge. Its computational power far exceeds that of even the greatest mathematical minds in history. It has access to enormous amounts of energy and knows nothing of fatigue, aging, illness, or anxiety. In short, AI is presented to us as something approaching the superhuman. And yet, we can only look with awe at what has unfolded in recent weeks.

Once such possibilities became visible, students and experts naturally began trying their chances on other longstanding problems. There are examples where, within a few hours, successful proofs have been obtained. These are remarkable achievements, and I do not intend to diminish them. Nor is this article an attempt to praise or criticize those who have used AI successfully. My purpose is quite different. I want to bring to the attention of our academic leadership and administration something that is possibly much less visible than the excitement surrounding these breakthroughs: the high level of worry and anxiety that they have created among mathematicians.

Mathematics, understood as a science built by human beings, is an invisible fabric extending from the most influential and creative researchers at the world's most prestigious research centers, through universities, colleges, and high schools, all the way down to those who teach young children to count, sometimes beginning with their fingers in kindergarten. Along this long continuum, every single part matters. We cannot simply leap from one point to another without losing something essential along the way. The growing presence of AI in our lives therefore naturally brings with it new ambiguities, as well as new sources of concern.

At first, a confession:

My own use of AI has so far been extremely modest. I have mainly used it for relatively simple tasks, such as polishing English or French texts, including this article. I have also recently worked with a collaborator who makes use of AI to check and verify results in a research paper. Beyond such uses, however, I remain largely unfamiliar with the capabilities of AI and, in particular, with how it might be used effectively and constructively in mathematical research or in making scientific discoveries. In fact, I use AI at what I would consider the lowest possible level, and I do not claim any real expertise in its use. Perhaps that is precisely why I am writing this note. I have observed various developments, spoken with colleagues and friends, and listened to many discussions, and all of these experiences have considerably increased my concerns. I therefore write simply as a non-expert, and perhaps somewhat old-fashioned mathematician, trying to make sense of a reality that is entering our professional and intellectual lives at an extraordinary speed. Thus, these reflections bring together optimism, realism, and a measure of apprehension about what lies ahead.

What Do We Mean by a 'Researcher' Now?

Let us begin with the three major criteria that grant agencies apply in evaluating our grant applications. The first is the quality of the researcher. Quite frankly, I think we now need to ask what we mean by a "researcher" in this new era. We may consider two extreme scenarios. On the one hand, a prominent colleague works on difficult problems, possibly from long before the AI era, and then, through back-and-forth assistance from AI, finds the right paths and settles the problem. On the other hand, another colleague puts all the burden of an open problem, including even the writing of the article, on the shoulders of AI and comes up with an article to claim authority on it. The spectrum of AI use is very wide, and the community is spread between the two extremes mentioned above.

It is likely that we will eventually reach an equilibrium point where colleagues properly exploit AI in their investigations. However, it is not clear when we will reach that point, and there is currently no means for institutions and grant agencies to categorize applicants and distinguish between their different levels and forms of use of the available technology. Hence, the question of assessing the quality of researchers remains wide open.

The question becomes even more complicated when some colleagues openly say that they have written a high number of research articles in the past year using AI, and that these articles have subsequently appeared in reputable peer-reviewed journals. At the same time, there remain traditional mathematicians who believe deeply in the intrinsic nature of mathematics, in the importance of struggling with a problem, developing intuition, making mistakes, finding the right question, and eventually discovering a proof. Their publication records do not remotely match those of colleagues who make extensive use of AI. The gap between these two categories seems to be growing rapidly. How can we fairly evaluate the quality of researchers in such an environment? I do not have an answer, but I believe we need to begin asking the question.

And What About the 'Proposal'?

The same phenomenon applies to the quality of a research proposal. As far as I understand, the agency does not currently have the means to determine whether a proposal was written with the assistance of AI, or even whether it was subsequently evaluated with the assistance of AI by external reviewers. The system essentially has to trust the candidates and the reviewers. This adds another degree of complexity to an already difficult process. More importantly, it creates a fear that some researchers may be disadvantaged simply because they use AI less extensively, or choose not to use it at all.

If one researcher spends weeks thinking about how to formulate a problem, explain its significance, and develop a research plan, while another can ask an AI system to generate and re-

fine a proposal in a fraction of the time, are we still measuring the same thing? And if AI becomes increasingly involved not only in writing proposals, but also in proposing research ideas, suggesting approaches and methodologies, and reviewing manuscripts, how should we distinguish and assess such proposals? These are not easy questions. But avoiding them will not make them disappear.

The Doctoral Student: My Greatest Worry

There is one issue that worries me more than all the others: the training of doctoral students. In the traditional approach, we give modest problems to fresh doctoral students and gradually guide them toward more complicated questions. We teach them techniques, but we also teach them how to think. We expect that, after four years of study, they will have developed enough mathematical maturity to approach problems that were initially beyond their reach. Along the way, we hope for a glorious outcome: a new theorem, a new method, perhaps even a new direction. But what happens when many of the modest, down-to-earth problems that we would traditionally give to beginning students can potentially be settled in half a day? How should we train doctoral students in such an environment?

Suppose we engage a student in a serious problem. The student spends months learning the background, trying approaches, failing, starting again, and slowly developing an understanding of the problem. Then, with a high probability, another AI-assisted group may answer the same question. What do I tell my student?

I feel responsible for the lives and careers of my students. I cannot accept the possibility of working with them for a couple of years and then being forced to say, "I am sorry; someone else has solved the problem." This is not merely a question of efficiency or academic competition. We are talking about the future of a young human being. And we are responsible for it. For me, this is the most worrying aspect of AI's invasion of our academic life.

A Possible Future Doctoral Program

The nature of doctoral training is changing rapidly, and we need to adapt to these changes. The training of doctoral students will likely look different in the future and will place greater emphasis on different goals. One possible direction (certainly not the only one) would be to have doctoral students take more courses and receive a broader education in mathematics. This could also lead to a new model of doctoral thesis, one in which producing a "new product" in the traditional sense is no longer the sole or even primary standard.

It is also conceivable that the number of students pursuing research careers will decrease. In that context, doctoral programs could place greater emphasis on broad mathematical education, preparing students to become better teachers and mentors. This does not mean transforming doctoral programs into education programs. Rather, students could take several inspiring mathematics courses that they can carry with them into their future positions. The doctoral student of the future may need to become a wise curator of mathematics, rather than necessarily a researcher in the traditional sense. Many doctoral graduates ultimately become mathematics professors whose primary responsibilities are teaching and mentoring, rather than research. A doctoral program that recognizes this reality could provide students with a broader, deeper, and more versatile mathematical education, while still preserving opportunities for those who wish to pursue research.

Will We Still Write Books?

Another, perhaps less important, issue concerns the writing of books. Being an author is a difficult task. It requires an enormous amount of energy, time, patience, and sacrifice. Moreover, after completing a book project, the rather meagre financial benefit that comes with its publication is yet another factor discouraging mathematicians from writing another one. Now add to this the fact that, for almost any topic, AI can potentially produce a well-organized document based on the available literature. Does it still make sense to write a new book? Perhaps the form of future mathematical publications will be totally different.

In fact, if you visit the office of a prominent professor and compare it with that of a recently hired colleague, you may already observe a major difference. The new professor may have only a few books in the office, together with a huge library of PDFs on a laptop, while the old-fashioned colleague's office is stuffed with all kinds of printed books and journals. This may sound like a trivial observation. But it is also symbolic. The way we store, access, read, and produce mathematical knowledge is already changing. And I suspect that we have seen only the beginning. More changes are ahead!

Perhaps we are moving toward a new kind of research institution, one with no traditional library and perhaps not even a dedicated office for each researcher. There may be little need to store large quantities of PDF files locally, since research materials could be accessed digitally whenever and wherever they are needed. Researchers and students would move back and forth between their residences and shared meeting rooms, while much of their intellectual interaction would take place through computer-mediated dialogue. The physical spaces might consist largely of meeting rooms without chalkboards or blackboards, complemented by access to sophisticated and highly specialized computing facilities. In such an institution, the traditional infrastructure of research would be replaced, to a large extent, by digital connectivity, shared computational resources, and some spaces for meetings and collaboration.

The Burden of Editorial Duties

The sheer volume of mathematics that AI-assisted systems may produce is difficult to comprehend. The number of submissions to research journals is already becoming a heavy burden for editorial teams. More fundamentally, if the pace of mathematical production increases dramatically, researchers may no longer have the capacity to absorb, evaluate, and make sense of everything that is being generated. We risk being overwhelmed not by a lack of mathematics, but by an abundance of it. Therefore, thicker volumes of research journals are not necessarily a sign of progress.

Mathematics requires time to digest. Understanding, connecting, simplifying, and placing new ideas within the broader mathematical landscape are essential parts of mathematical progress. In an AI-assisted future, one of the most important roles of mathematicians may therefore be not simply to produce more mathematics, but to curate, interpret, and digest the mathematics being produced.

Can AI Lead Us?

We have all experienced the familiar fact that every problem we solve immediately gives rise to a multitude of new ones. The landscape of mathematical questions is not finite or static; it resembles a tree, or perhaps a hyperbolic manifold, continually branching and expanding toward infinity. Human thought has repeatedly opened entirely new regions of this landscape by introducing new concepts, new theories, and new ways of looking at familiar problems. This capacity to move beyond the questions we already know how to ask has been one of the driving forces behind the development of mathematics and, more broadly, of science and technology.

AI is extraordinarily powerful when it comes to navigating an *existing* landscape. It can combine vast amounts of knowledge, recognize patterns, and help us solve problems that may be far beyond the computational abilities of any individual mathematician. But this raises a more fundamental question: can AI lead us somewhere genuinely new? Can it formulate a new theory, introduce a fundamentally new concept, or open a mathematical landscape that we did not previously know existed? More explicitly, solving a problem is not, by itself, the ultimate goal of mathematical research. What may matter even more is understanding where a solution takes us: what new questions it reveals, what unexpected connections it uncovers, and what unexplored territories lie beyond it. Can AI navigate that road, not merely by finding its way through an existing landscape, but by discovering or creating landscapes that were previously invisible to us? I am not convinced that it can. Perhaps this is precisely where human mathematical creativity remains indispensable.

The ability of AI to solve difficult mathematical problems by combining and deploying existing techniques is not necessarily the same as its ability to generate genuinely new mathematical ideas or conceptual frameworks. Mathematics has often advanced through conceptual leaps that were not simply the result of solving increasingly difficult technical problems, but rather through the introduction of new viewpoints, structures, and connections between seemingly distant areas. The formulation of the Langlands program, for example, illustrates how a powerful conceptual framework can open entirely new directions and influence mathematics for decades.

A Brighter Future for Teaching

One of the most exciting consequences of the current transformation may be a renaissance of mathematical teaching. As AI takes over much of the routine, technical, and laborious work of learning mathematics, the role of the teacher will not diminish. In fact, it will become more important than ever. The mathematics teacher of the future will need to be a master of the classroom: someone who can make mathematics beautiful, intelligible, and alive. Teachers will need to reveal the deep connections between ideas and help students see the larger landscape and the new galaxy of mathematical discoveries emerging before them. AI may take care of much of the *nitty-gritty*, but it cannot replace the human act of guiding a student toward understanding, curiosity, and wonder.

The teacher's greatest role will be that of a mentor: someone who can lead students through the ideas of mathematics, illuminate the paths between them, and inspire them to see mathematics not as a collection of techniques, but as one of humanity's greatest intellectual achievements. This may be the beginning of a new golden age of mathematical teaching. The uninspiring mathematics teacher may no longer have a place in the classroom, not because teaching has become less important, but because it has become too important to be done without excellence.

Make Mathematics Beautiful Again! Make it understandable. Make it exciting. Make students want to discover what lies beyond the next theorem. For thousands of years, mathematics has endured because it possesses a beauty and power unlike any other human creation. If we embrace this new era wisely, mathematics can once again, and perhaps more brilliantly than ever, take its place as one of the shining sciences of all time.

Final Comments

I have seen a high degree of anxiety among doctoral students and among younger colleagues at the beginning of their careers. I have also sensed a great deal of worry among supervisors about the future of their students. There are many other issues that could be discussed concerning the effect of AI on our academic life. I am neither an AI expert nor someone who knows how to use it effectively. There is no doubt that there are many remarkable and positive features coming with this new technology, and we will eventually learn how to adapt to the new reality. But adaptation does not necessarily mean that the passage will be smooth.

Mathematics has always evolved with new technologies, from the printing press to computers and computer-assisted proofs. Perhaps AI will ultimately become another instrument in this long history. But there is a difference between acquiring a new instrument and confronting a tool that may fundamentally alter the way mathematical ideas are generated, tested, communicated, and even valued. My concern is that we may gradually arrive at a situation in which a relatively small number of experts learn to use AI thoughtfully and creatively, using it to advance mathematical knowledge, while a much larger number of people come to rely on it primarily as a means of producing mass scientific output. The danger, in my view, is not simply that AI could make certain tasks easier. It is that the ease of producing apparently sophisticated mathematical work might outpace the development of the mathematical understanding needed to create, assess, and question that work. We could then find ourselves with an increasing volume of papers and results, while the proportion of people who genuinely understand the mathematics behind them becomes smaller.

This possibility concerns me deeply. Mathematics is not merely the production of correct-looking arguments or polished texts; it is an intellectual activity that requires understanding, judgment, intuition, and, above all, the ability to recognize why an argument is meaningful and why a result matters. I would be equally concerned if we reached a point where even the ability to formulate a simple, ordinary letter in our own words became something we routinely delegated to AI.

Perhaps these fears will prove unfounded. Perhaps the future generation will look back at my worries with the same amusement with which we now look at mathematicians who once feared calculators or computers. I sincerely hope so. But for the moment, I remain worried. But there is also reason for optimism. Ultimately, mathematicians still get to decide what mathematics is interesting, what is worth pursuing, what is worth reading, and what deserves our attention. We are not obliged to consume everything that can be produced. In this respect, mathematics may be rather like art: if you do not find a work meaningful, you are under no obligation to hang it on your wall.

Acknowledgments

I would like to thank my friends and colleagues who took the time to read different versions of this note and generously shared their thoughts, insights, and suggestions. Their comments have helped me clarify and improve several aspects of the discussion. In particular, I am grateful to E. Fricain, F. Gourdeau, A. Girouard, N. Kamran, D. Kinzebulatov, N. Nigam, T. Ransford, and W. Ross for their thoughtful comments, stimulating discussions, and valuable perspectives. I greatly appreciate their generosity in engaging with these ideas and helping me reflect more carefully on the questions raised by this rapidly evolving subject.

Any remaining errors or shortcomings are, of course, entirely my own.

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