Mathematics in the Age of AI

Building the Next Fifty Years

Opening remarks by Enrique Zuazua

Workshop on Recent Trends in Applied Mathematics and Machine Learning 2026
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Good morning. First of all, I would like to thank Professor Ran Zhang, Vice President of Jilin University, once again for her warm hospitality. Yesterday we attended a wonderful celebration of Jilin University's 80th anniversary. Over these eight decades, the world has experienced profound political, social and economic changes, including wars and periods of both prosperity and hardship. Through all these changes, throughout all these years, the university has remained a stable institution, supporting the development and transformation of society in Northeast China.

The celebration reminded us of the enduring importance of institutions. Individuals come and go, but institutions remain. We heard from people who studied and worked here perhaps sixty years ago or more and who are still active and connected to the university. Their testimonies were deeply inspiring and moving. They reminded us that a university connects generations. It receives knowledge from the past and prepares young people to shape the future.

This is a wonderful setting in which to begin the third edition of our workshop. The idea emerged naturally in my conversations with Professor Ran Zhang, some five years ago now. She leads, among other initiatives, an important effort to attract outstanding scholars and young people to this institution in the field of the mathematical sciences, and to build a prosperous future for the field, the results of which are already visible. It is an honour for our workshop to contribute to this global effort and, in this edition, to be associated with this very special anniversary.

Our workshop addresses diverse topics in the mathematical sciences: control, numerical and computational mathematics and, increasingly, machine learning and AI. And the timing is especially appropriate. We have all seen how artificial intelligence is transforming our daily lives and our work. It is also challenging us to reconsider our roles as educators and researchers.

Indeed, tools such as ChatGPT and DeepSeek can already help us answer many of the mathematical questions we have been working on, sometimes even before we ourselves have been able to work them out. Therefore, we now need to ask how mathematics and AI can develop in harmony, and what we, as mathematicians, should contribute to that development.

I remember first hearing about ChatGPT while travelling by train to a workshop in Germany. I was leaving Erlangen, and Andy Maier was sitting next to me. He leads the Chair of Pattern Recognition at our university, FAU. He asked whether I had tried ChatGPT. At first, I thought it was merely a tool for correcting text. Why did I need it when I already had other tools that could correct my typing and spelling, translate, and so on? He encouraged me to try it.

That conversation took place only a few years ago, three perhaps. Today, these tools can draw on a vast body of mathematical knowledge and help us with questions about the convergence of numerical schemes or asymptotic expansions for partial differential equations that were previously within the reach only of the most competent experts. And they can also help us recover knowledge that we have forgotten. Perhaps in the past, fifteen years ago, we studied interpolation theory for Sobolev spaces, but we no longer remember whether a particular result requires a Lipschitz domain or a continuously differentiable boundary. AI can help us find and check such details, although we must still verify its answers to be sure that they are absolutely rigorous.

AI has become a virtual colleague, synthetic, non-organic, always available, with a great memory, who explains the most complex concepts with mastery and, moreover, does so in multiple languages, who knows everything written up to now, who never forgets, who never sleeps, who never gets irritated.

In Erlangen, we have a long tradition of connecting mathematics, computing and applications. Radon, who developed the transform that bears his name, was a professor at the university. Erlangen is also home to Siemens. Although many people associate Siemens with household appliances, it develops advanced medical technology, including magnetic resonance imaging equipment. Our university's medical centre, Siemens and pattern recognition research form an extremely strong scientific triangle. Much of this work is driven by computer scientists from our school of engineering. Mathematicians have sometimes been slower to engage, but we are doing it now through initiatives such as our Mathematics of Data – MoD Center.

This anecdote is part of a much longer and global story, which is, in fact, the story of humanity. Human beings have transformed their lives through language and science. Language allows us to communicate and organise ourselves into communities, institutions and civilisations. Science allows us to understand the world and change the way we live in it. Universities bring these two activities together: the creation of knowledge and its transmission from one generation to the next.

Mathematics has always been part of this effort; it has been its principal guarantor. Early mathematicians asked how planets move, how distances can be calculated and how large the Earth is. Over time, mathematics evolved towards greater abstraction, while continuing to respond to practical problems. The development of

modern computers opened another chapter. We might know how to solve a problem, but the number of steps could be so large that we would never finish within the time available. We needed machines to accelerate the work.

I first heard the word informatics about fifty years ago, when universities began offering a degree in the discipline. The older brother of one of my best friends had enrolled in a course with that name, "Informatics", at the University of Deusto, in Bilbao, in the Basque Country, in northern Spain, to which I am now connected, for about ten years. Later, in the 1990s, I had the opportunity to witness how the degree began to be offered at the Universidad Autónoma de Madrid, to which I have also been connected for some twenty-five years.

Control science, which we address in this workshop, has played an important role in this history. We have built machines to perform tasks and gain freedom, pursuing an objective that was already established by those philosophers who, in ancient Greece, sowed the foundations of our civilisation. Now, water reaches our kitchens, heating systems regulate the temperature, and many functions in cars and aircraft operate automatically. Behind these achievements, now turned into everyday realities, to the point that we inadvertently ignore their importance, lie mathematical ideas, particularly the principles of feedback control.

In 1948, Wiener described cybernetics in terms of control and communication in animals and machines. Today, we see new forms of this connection in robotics and AI. Robots can dance and practise kung fu, while AI chats and apps are changing how people work with information and knowledge. These developments invite us to think carefully about our own future.

Will mathematics still need professors, or could an AI tool, together with a robot, take on part of that role? A robot could speak clearly and confidently and answer questions in many languages. If a student asks about the connection between generative AI and classical Monte Carlo methods, it might reply politely: "That is a very good question. Yes, there is a connection." The student would probably receive an answer. But would that answer be correct? Would the student understand it? And would it help the student ask a better question?

These are responsibilities that we must continue to take seriously. Our role will increasingly be to ask the right questions, to judge whether an answer is correct and meaningful, and to decide which problems deserve our attention. We must also teach young people how to do this, in order to continue transmitting knowledge. Let us not forget that we are no more than a link in a chain that grows incessantly. The power of the new AI tools makes these responsibilities increasingly important and pressing.

As teachers, we must help students use AI without giving up their own judgement. That is why they still need to understand a proof, to understand what rigour means,

to recognise when a hypothesis is missing, and to explain why a result matters. As researchers, we must explore what these new tools make possible, while bringing the precision and depth that mathematics requires.

We need to respond with ambition and imagination. The familiar framework of our applied mathematics, in which we have lived until now, is running out of oxygen; we need to go beyond it, open windows and create a larger space in which mathematics can develop for at least the next fifty years. The history of Jilin University reminds us that institutions endure because successive generations continue to renew them. The same is true of scientific disciplines. Now it is our turn to be the protagonists of that renewal.

This workshop gives us the opportunity to address this task with concrete questions. Which problems in control and computation can AI help us solve? How can mathematics explain the workings and reliability of these new AI-based methods? And how should we prepare students to work in this changing environment? I hope that these questions will enter our discussions, alongside the specific results presented in each of the talks.

The task is twofold. We must continue to address the problems in our own areas of expertise and seek classical mathematical answers. At the same time, we need to bring disciplines together and remain open to new questions. The future will certainly differ from the present, and we should help shape it. We must immerse ourselves in it without reservations so that we can continue to grow within it.

Jilin is an excellent place to pursue this effort. I am delighted to be here again, and I hope that we will have further opportunities to meet and continue this workshop in the future. I am convinced that Jilin will remain a place conducive to mathematical thought, research and education for many years to come.

I hope that everyone enjoys the hospitality of Jilin University and of the region. The food is delicious, and the warm welcome of its people makes it a true pleasure to be in Jilin. I wish you all a fruitful workshop, with good and stimulating mathematical discussions and new ideas to take back home. Thank you very much.