

Bringing artificial intelligence to mathematical practice

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Leverhulme Emeritus fellowship 2024-2026

"Working with an interdisciplinary team, Ursula Martin asks whether AI will change the nature of mathematics"

Picture a mathematician – what do you see? An isolated individual scribbling mysterious formulas on a blackboard, spotting something interesting, and then creating an ingenious proof of it to convince their peers? A research team using sophisticated mathematical models to design a new medical device and check that it is free from bugs?

Now, add modern artificial intelligence – software that tries to answer questions by analysing vast quantities of data – whether words, pictures, numbers or formulas – to learn novel patterns. Over the past few years, there has been striking evidence that this can help research mathematicians in their work. For example, in 2021, Oxford and Sydney academics working with DeepMind found some totally novel results about the mathematics of knots. Guided by humans, DeepMind's software came up with many seemingly plausible new ideas – human skill and judgement were needed to decide which of these seemed interesting enough to investigate and then to devise convincing proofs.

It goes further – with some human guidance, computers can devise original mathematical proofs and check them by relentlessly applying detailed logic that humans are unlikely to have the patience to match.

My Leverhulme-funded project looks in the round at what these developments mean for so-called 'mathematical practice', the unique range of knowledge and skills currently deployed by human mathematicians. We ask if there are human qualities essential to mathematical practice, for example, whether machines can ever replace human judgement to identify significance within AI-generated mathematical abundance. We might wonder about the risks and ethical concerns of working with AI when we don't know much about the quality or sources of the underlying data it uses. Building such AI resources is costly, meaning partnerships with commercial AI companies are almost inevitable, so there is concern that this clashes with traditional mathematical values of transparency and accessibility, restricting the availability of mathematical knowledge.

This is a fast-moving field in which smart people are coming up with new ideas that would have been totally infeasible until a couple of years ago. Our interdisciplinary team - historians, social scientists, philosophers, mathematicians and computer scientists - aim to work alongside them to increase understanding of the applications of AI in mathematics, and to identify potential impacts - good and bad - of its widespread use.