



Mathematics

Topic

Automated mathematics

Background

Developments in technology (particularly in AI and automation) have constantly pushed us to reconsider our own roles in the workforce. Creative human endeavours traditionally seem as safe from machine intervention such as painting and poetry may seem under threat by the likes of DALL-E and ChatGPT and, in principle, mathematics is no exception.

Mathematicians have relied on mechanical assistance in their work since at least the first abacus was invented, but they were not seen as *essential* tools, but mere facilitators (the same can be said of contemporary calculators). However, certain advances in modern mathematics have relied on computers to verify important results, the most notorious case being that of the Four Colour Theorem, which states that any map on a plane can be colored using only four colors in such a way that no two adjacent regions have the same color. The proof given in 1976 involved the use of a computer to check the validity of a large number of cases.

In the late 1960s and early 1970s, researchers began developing software systems that could automatically generate and verify mathematical proofs, laying the foundation for modern proof assistants such as *Coq*, *Isabelle* and *Lean*. These provide a qualitative next step, as they can be semi-automatic and help guide a human mathematician through a proof (who in turn can give the program new inputs), or be fully automated. In the future, we may be able to develop a system that searches for *mathematical concepts* themselves, rather than their names, and create software that can replicate human approaches to problems.

Guidance

There are many directions one could go here, but you can pick one of the following three suggestions:

1. Imagine some possible uses for a proof assistant. Can you think of ways these technologies can help people both inside and outside of universities? What are some limitations that we should be aware of?
2. How reliable are tools like ChatGPT when dealing with mathematics at the moment? Discuss potential mistakes that could be made using such software and share your thoughts on how the role of the mathematician might change compared to now as these technologies mature.
3. Read about some proof assistant (say, *Lean*) and try to roughly explain how it works. If you are feeling adventurous, why don't you try to prove something simple about numbers using it? You can find a tutorial [here](#).

Presentation

The format of your presentation depends on what you wish to discuss, but both essays (with perhaps some code in case you decided to give *Lean* a try) or videos explaining your ideas would be suitable.