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Collaboration With Our New Robot Overlords

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The Canadian SF writer Robert Sawyer once wrote a short story ("Flashes", 2006) in which an alien civilization beams enormous quantities of information to Earth. Some of it was clearly knowledge for which humans were not mature enough — for instance, how to make antimatter in weaponizable quantities with easily available equipment. There was also a description of a wave of despair among researchers in the mathematical and physical sciences, who suddenly find themselves centuries behind the cutting edge of research. It did not end well.

In the last couple years, the Notes has run some articles about generative AI and large language models. At first most people I know who thought about this software at all thought in terms of undergraduate students having a new way to cheat in unsupervised essay-writing, or as a more flexible way to create boiler-plate letters of recommendation. But in the last year or so there have been announcements that have to make any mathematician sit up and take notice.

For instance, there have been reports of AIs (specialized for the task, and using incredible amounts of processing power) getting medal-level scores on IMO papers. More recently, several conjectures of Erdős have been resolved using AI. Most recent among these is Erdős's "unit distance problem." The problem is to find configurations of n points in the plane in which the maximum number of pairs are at distance 1. Erdős conjectured that the number of unit distances would be $O(n^{1+c/\log\log n})$. The AI showed that it is at least $O(n^{1+\epsilon})$.

It's worth stressing that the computer's role was not doing a massive grind through thousands of alternatives (as in Appel and Haken's 1976 proof of the four-color conjecture); the proof is much like something a human might have come up with, apparently quite direct and readable if you have the background, and indeed it largely links together known results from (quite disparate) areas of math.

There's no doubt that something has happened. And we can't write it off by saying "the invention of the bicycle didn't destroy interest in foot racing" as the wise did when the first computer beat a chess grand master. But the boundary between computers' work and people's work has been shifting for over a century.

In 1903 Frank Nelson Cole exhibited the factors of the 67th Mersenne number at an AMS conference, making explicit an 1876 existence proof by Lucas. He spent an hour doing the exponentiation and mutiplication by hand on the blackboard (brave fellow!) and earned a standing ovation. Finding the factors had taken him far longer than that, "three years of Sundays" by his account Just now, I opened MAPLE on the HP laptop I'm writing this on, and typed

> ifactor(2^67 – 1);

The answer

(761838257287)*(193707721)

came back in a fraction of a second. (Sorry, Frank.) Has romance vanished from the mathematical world? Has the pale algorithm conquered the great Pan? With due respect, I think not. Number theorists can use this new facility with factorization to do much more interesting things.

We may be at the dawn of a new age in mathematics, but this is not happening for the first time, and I believe that this age, too, will have a place in it for humans–and more interesting problems than we can solve, even with computer help. If you have an opinion on this, please send it to us: whatever the outcome, it's probably important to our field. (Any persuasive argument that it really is just a flash in the pan will, however, be read with particular interest.)