BOOK REVIEW

Machines Like Me and A Universe of Sufficient Size

Reviewed by Alex Kasman

Machines Like Me

by Ian McEwan

A Universe of Sufficient Size

by Miriam Sved

The two books being reviewed together here may at first not appear to have anything in common. The first is Ian McEwan's *Machines Like Me* [McE], a science-fiction novel about two neighbors in a London apartment building who together purchase an artificially intelligent android. The other, *A Universe of Sufficient Size* by Miriam Sved [Sve], is an entirely realistic novel about the Holocaust and its effects on some Hungarian survivors and their descendants.

It turns out that these two seemingly very different novels have a commonality that is mathematical. Both books contain characters whose life stories start out identical to the biographies of some famous mathematicians before eventually deviating from the true stories in fundamental and dramatic ways. One can read and enjoy these novels without knowing about the lives of the real mathematicians on whom the characters are based, but a deeper appreciation is available to readers familiar with the historical facts.

Significantly modifying the histories of recognizable mathematicians is rare in fiction. Usually, works of fiction which include famous mathematicians as characters attempt to remain consistent with the known facts of the individual's life. For example, novels like *Beyond the Limit: The Dream of Sofya Kovalevskaya* by Joan Spicci and *D'Alembert's Principle: A Novel in Three Panels* by Andrew Crumey

are nearly biographies in fictional form. Even fantastical works like Paul Nahin's short story "Newton's Gift," in which a time traveler brings Isaac Newton a digital electric calculator, generally avoid directly contradicting history, as if they are only telling us parts of the biography that had been forgotten but still fit in with what is known. Other works of fiction create entirely imaginary mathematicians, intended to be distinct from any real people. Examples of this include the former judo wrestler and Fields Medal-winning knot theorist from Peter Buwalda's novel *Bonita Avenue* or the world-famous African mathematical physicist in Greg Egan's science fiction novel *Distress* whose theory of quantum gravity makes her the subject of death threats. It is therefore notable that these two literary novels published in the same year both include alternate histories of recognizable mathematicians.

Machines Like Me presents an alternative history not only of the life of one mathematician but of the whole world. The universe in which it takes place appears to be nearly identical to ours up until the 1950s, but the pace of technological innovation after that was so much more rapid there that laptops, smart phones, and the internet were all in wide use by the 1980s. In addition, lifelike androids (like Adam, the artificially intelligent android jointly "adopted" by neighbors Charlie and Miranda at the start of the novel) were just becoming available for purchase in that decade. Other notable differences between that universe and our own include that Britain suffered a humiliating defeat in the Falklands Islands War and that the Beatles reunited.

The reader can trace most of these differences back to a decision made by the famous mathematician Alan Turing during his sentencing hearing on the charges of "homosexual activity." Unlike our universe where Turing chose chemical castration as a punishment, the Turing in McEwan's alternative history chooses imprisonment. While in

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prison he is motivated to work on math research and does not take his own life. The future seems to arrive earlier as a consequence of the fact that Turing lives beyond 1954, especially at the intersection of computational biology, computer science, and mathematics where he frequently worked. For example, the fictional Turing first comes to the attention of the general populace in 1968 after a computer program that he wrote with a colleague named Demis Hassabis beats a champion at the Japanese game "Go" using deep learning techniques. In contrast, the real Demis Hassabis and his company were not making news for similar achievements until 2017 (see [Hass]).

The most significant mathematical result attributed to Turing in *Machines Like Me* is something that nobody has done in reality, at least not yet. Between working with Francis Crick on protein structure and helping to develop the first protocols for the internet, Turing resolved the P vs. NP question. In brief, this famous open question (currently one of seven Millennium Prize Problems carrying a million dollar prize from the Clay Mathematics Institute) is about whether two classes of computational problems are the same, or whether solving problems in one of the classes is so much more time consuming as to make them practically unsolvable. Long after he began thinking about this problem while in prison, fictional Turing and "two King's College Cambridge friends" publish a proof that the two classes are the same. This theorem did more than simply show that P is equal to NP; it also provided an effective way to solve computational problems that we cannot currently answer in a reasonable amount of time. This breakthrough was a prerequisite for the development of the artificial intelligence utilized by androids like Adam. As Turing explains to Charlie:

"Simple statements need external information to be understood because language is as open a system as life. I hunted the bear with my knife. I hunted the bear with my wife. Without thinking about it, you know that you can't use your wife to kill a bear. The second sentence is easy to understand, even though it doesn't contain all of the necessary information. A machine would struggle.

"And for some years so did we. At last we broke through by finding the positive solution to P versus NP—I don't have time now to explain it. You can look it up for yourself. In a nutshell, some solutions to problems can be easily verified once you've been given the right answer. Does that mean therefore that it's possible to solve them in advance? At last the mathematics was saying yes, it's possible, and here's how. Our computers no longer had to sample the world on a trial-and-error basis and correct for best solutions. We had a means

of instantly predicting the best routes to an answer. It was liberation. The floodgates opened. Self-awareness and every emotion came within our technical reach...."

By the 1980s, Alan Turing has become a public figure like Elon Musk and Mark Zuckerberg. He is rich, powerful, and famous, but unusually for a tech company CEO, he is also a proponent of the open-source movement. The author shows us that this benevolence has some unexpected consequences. *Science* and *Nature* both cease publication as a result of competition from the open-source journals that Turing promotes. The book also explains that the reason Argentina was able to massacre the British navy in the Falklands Islands War is that they used Turing's freely available algorithms in their missiles.

Obviously, it is heartwarming to see Alan Turing avoid the punishment and tragic death that he suffered in reality. There are other interesting comparisons that can be made between our universe and this alternative, some of which are hidden like "Easter eggs" for people who know enough about Turing. Since he is often given a lot of credit for the Allied victory in World War II (although his role has been diminished as the contributions of others have come to light in recent years), it is ironic that in the book Alan Turing takes the blame for the casualties suffered by the British navy in the Falklands. Also, although the alternate Turing does not take his own life, the artificially intelligent androids that he helped to develop do begin to commit suicide at an alarming rate. (Indeed, once Turing becomes a character in the book, this is the topic he mainly discusses with Charlie.) And, there is a funny scene in which Miranda introduces Charlie (now her fiancé) and their android Adam to her father who becomes confused about which of them is the human. Charlie eventually realizes that he has been mistaken for a robot and has some fun playing along with the error in a clever reversal of the standard "Turing test."

There certainly is more to *Machines Like Me* than the part about Alan Turing. For the first half of the book, he is only in the background of the story. And, even after Turing begins appearing as a character, he is still a relatively minor character. The book mostly concerns the bizarre relationship between Miranda, Charlie, and Adam. Another major focal point is the quest for justice in a rape that occurred many years earlier, a subplot somewhat reminiscent of McEwan's more famous novel, *Atonement*.

Mathematics also appears in *Machines Like Me* in a few ways that are not directly connected to Turing. Charlie, a slacker who seemingly does little other than some unsuccessful day trading, expresses interest in studying mathematics formally. At one point he uses mathematical metaphors to describe his feelings about Miranda, saying she is like a "counter-intuitive Euclidean proof." And, Adam refers to Bayesian Probability and his selection of

priors when explaining his thought processes to his human owners. Someone reading this novel who was not already interested in mathematics could easily ignore those brief digressions. However, the character of Alan Turing, who is given an opportunity to revisit some of the book's main philosophical themes in a monologue near the end, will certainly leave an impression on any reader. His prescience and wisdom along with the tremendous consequences of his mathematical research could leave a reader with a better opinion of the whole field of mathematics.

Now, let us turn our attention to Miriam Sved's novel *A Universe of Sufficient Size*. I could describe its plot as follows:

Five Jewish friends do mathematics together in Budapest as Hitler comes to power in nearby Germany. They must meet in a public park to do their work because anti-Semitic laws ban the three male members from the university campus. The two women enroll as students, although quotas designed to reduce the number of Jews in academia force one to study physics rather than mathematics. Many years later, in Australia, the grandchild of one of the women meets the most famous member of the group, a prolific mathematician famous for having no permanent home but instead staying with his collaborators as he travels around the world.

That paragraph both accurately describes the events in *A Universe of Sufficient Size* and completely matches the well-known true story of mathematicians George Szekeres, Esther Klein, Marta Sved, Pál Turán, and Paul Erdős. It is a story that the author knows well since Miriam Sved is the Australian grandchild of Marta Sved and she very briefly describes her own real meeting with Paul Erdős in the book's acknowledgments. Yet, as we will soon see, the famous mathematician and grandchild of his old friend from Budapest who meet in her novel are definitely not Paul Erdős and Miriam Sved.

In contrast with McEwan's alternate history, the rest of the world in this novel seems to be essentially the same as the one we live in. No technologies were developed sooner; no wars had different outcomes. However, the trajectory of the lives of the five Hungarian mathematicians is very different than those of the real people who inspired them. Moreover, in *A Universe of Sufficient Size*, their names have also been changed. For instance, the Erdős-like character is named "Pali Kalmar."

Whereas mathematics is only in the background of *Machines Like Me*, it often drives the plot in *A Universe of Sufficient Size*. Most prominently, much of the book revolves around a question involving polygons drawn among random assortments of points in the plane. The novel alone does not provide enough information to figure out precisely what the question is, but those familiar with the history of combinatorics will guess that it is the question of finding the smallest number m guaranteeing the existence of a convex n -gon among m vertices in general position. The special case $m = 5$ and $n = 4$ is the problem that Esther Klein first raised with her friends in that park

in Budapest. Erdős called it "The Happy Ending Problem" because its resolution led to the marriage between Esther and George Szekeres.

A 1935 paper by Erdős and Szekeres shows more generally that there exists a finite m for each n , but the precise values remain unknown. This is one of the open questions of the field now known as Ramsey Theory, and it is presumably what the novel calls "The Upper-Limit Problem." One can only presume because the mathematics is only described in vague terms throughout the book. The lack of mathematical detail is not surprising since the mathematics is not really the main point of the novel. The characters may happen to be mathematicians, but the book is about life and death and dysfunctional family dynamics. The author tries to connect the big philosophical questions to the math by hinting at an analogy between finding meaning in a chaotic universe and finding convex polygons among randomly distributed vertices.

Miriam Sved could have written a work of fiction around that analogy which was consistent with the facts we know about the lives of these five individuals. Among the sources of factual information on this topic is her own grandmother's memoir entitled *Two Lives and a Bonus*. However, Sved chose otherwise. Like Turing's in *Machines Like Me*, the life stories of these characters which are initially identical to the ones we know from history become dramatically different. Unfortunately, I cannot really convey to you how dramatically they deviate without spoiling the biggest surprise of the novel. So, for the most part, you will either have to trust me or read the novel yourself.

But, there is one particular difference between the true biographies and those of the characters in the novel that I feel I can safely discuss. Although Paul Erdős died in 1996, his fictional doppelgänger Pali Kalmar was alive in 2007 speaking about mathematics at an Australian university. In the audience is a student who is interested in mathematically modeling information exchange on the internet, another topic like the Happy Ending Problem involving the combinatorics of discrete graphs. The student is surprised to learn that his grandmother was one of the group of friends who first studied those problems in a park in Budapest. In an entirely fictional "happy ending," he ends up collaborating with Pali Kalmar himself on the Upper-Limit Problem.

As in reality, the prolific, itinerant mathematician met the grandchild of one of his old friends from Hungary in Australia. However, in other ways the story is very different than reality. Miriam Sved met Paul Erdős when she was a young child and is not particularly interested in math, while the character in the book is a college student who works with Pali Kalmar after developing an interest in the mathematics of computer networks.

This last point raises another intriguing similarity between the two novels being reviewed here. In reality, digital computers were rare items and computer networks were in their infancy during the lifetimes of both Alan Turing and

Paul Erdős. Coincidentally, both of the books extend the lives of the fictional mathematicians beyond those of the historical figures, altering history so that they survive to see the ubiquity of digital computers and the importance of the internet in the lives of ordinary people today. Moreover, both books suggest that the research done by these mathematicians laid the theoretical foundation for those technologies. The extent to which that is true is debatable, but it is surely good for the field of mathematics that readers of these novels will encounter this evidence for the value of mathematical research, even if it is in fictional form.

That is still not all that these books have in common. Many works of “mathematical fiction” portray mathematicians in ways that concern me. Often, mathematicians are portrayed as being extremely antisocial and “quirky.” (See, for example, the portrayal of Alan Turing in the film *The Imitation Game*.) In other works of fiction, mathematicians are emotionally cold or even evil. I am therefore pleased to say that neither of these novels stoops to using such mathematical stereotypes. Like the other characters in the books, the mathematicians are well-rounded “normal people” with complex relationships and positive attributes as well as flaws and quirks.

Both works also arguably exaggerate the importance of the mathematicians they describe. We will never know for certain what the world would be like had Alan Turing lived into the 1980s, but I think it is safe to say that it is *unlikely* that he would have proved “ $P=NP$ ” and used that as a way to create powerful AIs. A stronger argument can be made that *A Universe of Sufficient Size* could leave the reader with an exaggerated impression of the importance of Paul Erdős to mathematics. Certainly, he was a very colorful individual as well as a prolific researcher. Many mathematicians know their Erdős number. But, Pali Kalmar seems to be the most important mathematician of the 20th century with an unmatched influence on every subdiscipline of math. One example of this occurs when one of the female mathematicians from the group of Hungarian friends goes back to earn a PhD many years later in Australia. She chooses the field of “abstract geometry” hoping that this field is sufficiently far from combinatorics that she will not have to hear anything about her old friend, but her advisor’s first bit of advice to his new student is to read Kalmar’s writings because he “defined the limits of what was interesting.” Perhaps the need for exaggerations such as these is taken for granted in fiction.

Despite those minor complaints, I strongly recommend both books, not only for the mathematician characters whose life stories may sound familiar to you, but also because they are well written and thought provoking. (For more recommendations and reviews, please also visit my website [Kas] where I am attempting to catalog all works of “mathematical fiction.”)

Bibliography

- [Hass] Elizabeth Gibney, *Self-taught AI is best yet at strategy game Go*, Nature (2017). <https://www.nature.com/news/self-taught-ai-is-best-yet-at-strategy-game-go-1.22858>
- [Kas] Mathematical Fiction homepage, kasmana.people.cofc.edu/MATHFICT/
- [McE] Ian McEwan, *Machines Like Me*, Nan A. Talese, 2019, 352 pp.
- [Sve] Miriam Sved, *A Universe of Sufficient Size*, Picador by Pan Macmillan Australia Pty Ltd, 2019, 311 pp.

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