

Interesting mathematical reading

Timothy Hume¹

Introduction

In this article we present brief summaries of some mathematical articles which readers may be interested in. If this list of readings proves popular, it may become a regular feature in *Parabola*.

The original idea behind presenting suggested readings came from the recommended readings lists often found in public libraries. Instead of “What should I read after I’ve read Harry Potter?”, this is more of a “What should I read after I’ve read *Parabola*?” We intend to briefly summarise a few mathematical articles which are freely available over the Internet, to encourage the reader to read the full article. When selecting articles to include, we aim to ensure the following requirements are met:

- (a) Articles will be from reputable sources.
- (b) Articles must be freely available to all *Parabola* readers. This means no articles will be behind pay-walls or require paid journal subscriptions.
- (c) Articles will not eclipse or replace existing or potential *Parabola* articles.

So without further ado, we present three articles which hopefully readers will find interesting and thought provoking. This edition’s articles cover a broad historical range. We start with an article about hybrid binary counting system used in Polynesia which pre-dates the use of binary in Europe by hundreds of years. Then we introduce a little-known, ground-breaking mathematician from the early Twentieth Century. Finally we ask the question, will mathematics be automated in the future?

¹Tim Hume (tim@nomuka.com) works as a meteorologist.

1 Polynesian counting systems

The formal description of the binary system is usually attributed to Leibniz in the early Eighteenth Century. Binary arithmetic now forms the basis of modern computing²

However, recent research by psychologists and cultural anthropologists Andrea Bender and Sieghard Beller has found a hybrid decimal-binary system was in use in the island of Mangareva from at least 1450CE [3]. Mangareva is in the Gambier island group of French Polynesia (refer to Figure 1).

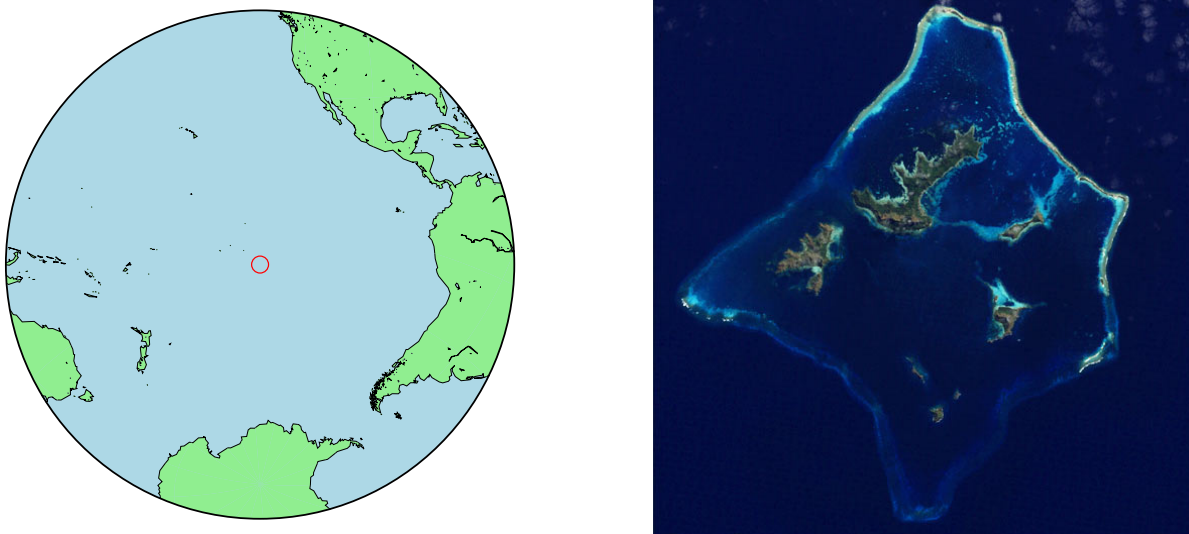


Figure 1: Map (left panel) and satellite view (right panel) of Mangareva. Mangareva is the large island near the centre of the satellite image, indicated by the red circle on the map.

The Mangarevan counting system contains the numbers one through nine. Beyond nine, there are words for ten, twenty (2×10), forty ($2^2 \times 10$), and eighty ($2^3 \times 10$). For example, the number seventy-five is represented (using words) as forty, twenty, ten and five:

$$75 = 0 \times 80 + 1 \times 40 + 1 \times 20 + 1 \times 10 + 5.$$

The hybrid binary-decimal numbers are reserved for counting valuable objects such as turtles and coconuts. Ordinary objects are counted using a decimal system, which has words for large powers of ten.

The use of words for non-decimal collections of objects is common in languages throughout Polynesia and the rest of the world. For example, in English we have pair, dozen, score and so on. However, these words tend to be used somewhat haphazardly. What makes the Mangarevan system different is the systematic use of the hybrid decimal-binary numbers for counting of valuable objects.

²Not all computers have used binary arithmetic. At the dawn of the electronic computing era, ternary computers were developed in the Soviet Union. These ternary computers were cheaper to produce than comparable binary machines [4].

For further insight on how the Mangarevans used this hybrid counting system, read the paper *Mangarevan invention of binary steps for easier calculation* [3]. Sadly the Mangarevan language is in trouble, with only about six hundred speakers remaining in 2011.

2 Emmy Noether

In an obituary published in the *New York Times* in 1935, Albert Einstein writes:

Within the past few days a distinguished mathematician, Professor Emmy Noether, formerly connected with the University of Göttingen and for the past two years at Bryn Mawr College, died in her fifty-third year. In the judgment of the most competent living mathematicians, Fräulein Noether was the most significant creative mathematical genius thus far produced since the higher education of women began [6].



Emmy Noether. Image from the Bryn Mawr College Special Collections archive.

But, who is Emmy Noether? Most people have heard of Einstein. However, outside of the physics and mathematics community very few people have heard of Emmy Noether. When I asked my colleagues in the Bureau of Meteorology (who generally have backgrounds in the physical sciences or mathematics), only one person knew who she was.

In 2018, on the one hundredth anniversary of one of Noether's most famous theorems, a number of articles were published on her life and work. For readers interested in finding out more about this unnoticed mathematician, two good articles to start with are included in the list of references. The first is an editorial published in *Nature: Celebrate the mathematics of Emmy Noether* [7]. The second is a feature article in *Science News: In her short life, mathematician Emmy Noether changed the face of physics* [5]. The latter article also has a number of further references for more in depth reading.

Unfortunately, a century later women are still underrepresented in the physical sciences and mathematics. A recent report found that only 37.8% of students studying higher mathematics at year 12 level in Australian secondary schools were female [2]. It is clear that progress in this area is still required.

3 Automation of mathematics

In 2017, the Australian Broadcasting Corporation published a series of articles on how susceptible various jobs were to automation [1]. The categories of jobs ranged from those which were highly susceptible to automation, such as construction and mining labourers (with a rating of 86 %), to those which were very “safe” from automation, such as insurance agents and sales representatives (with a rating of 7 %). An interesting question is, how susceptible to automation is a mathematician’s job?

In the 1970s, mathematician Paul Cohen predicted that “at some unspecified future time, mathematicians would be replaced by computers.”. A recent article by Stephen Ornes in *Quanta Magazine* provides a fascinating overview of the use of computers and artificial intelligence algorithms to solve mathematical problems. Already several conjectures, such as the Four Colour Theorem, have been solved with the aid of computers. To find out more, read the article *How close are computers to automating mathematical reasoning?* [8].

Of course, there are many conjectures which we would love to know the truth of. However, if a computer proof is not understandable to humans, is it satisfying, even if we know it is probably correct? I personally suspect that computers will not replace the role of human mathematicians, but will instead be seen as useful tools in a mathematician’s arsenal. Finally, mathematicians may be able to draw some comfort from the chess world. Since the computer *Deep Blue* beat grandmaster Garry Kasparov in late 1990s, computers have been able to easily beat humans at chess. Yet the game remains as popular as ever amongst millions of players. Indeed, there is a community of programmers who now strive to make the best computer chess engines, and there is a World Computer Chess Championship to pit the various engines against each other!

Acknowledgements

I would like to thank Thomas Britz for suggesting the articles on Emmy Noether and the automation of mathematics.

All online resources referenced to below were last accessed on 2020-12-06.

References

- [1] J. Byrd, B. Spraggon, M. O'Neill and M. Liddy, *Could A Robot Do Your Job*, Australian Broadcasting Corporation,
<https://www.abc.net.au/news/2017-08-08/could-a-robot-do-your-job-artificial-intelligence/8782174?nw=0>.
- [2] S. James, *Year 12 Mathematics Participation in Australia 2008–2017*, Australian Mathematical Sciences Institute, 2019, <https://amsi.org.au/preview-year-12-mathematics-participation-in-australia-2008-2017/>.
- [3] A. Bender and B. Sieghard, Mangarevan invention of binary steps for easier calculation, *Proceedings of the National Academy of Sciences of the United States of America* **111** (2014), 1322–1327.
<https://www.pnas.org/content/111/4/1322>.
- [4] N.P. Brusentsov and J.R. Alvarez, Ternary Computers: The Setun and the Setun 70, in *Perspectives on Soviet and Russian Computing*, Eds. J. Impagliazzo and E. Proydakov, pages 74–80, Springer, 2006,
https://link.springer.com/chapter/10.1007/978-3-642-22816-2_10.
- [5] E. Conover, In her short life, mathematician Emmy Noether changed the face of physics, *Science News* (2018), <https://www.sciencenews.org/article/emmy-noether-theorem-legacy-physics-math>.
- [6] A. Einstein, Emmy Noether. NY Times obituary. Professor Einstein Writes in Appreciation of a Fellow-Mathematician, *New York Times* 5 May 1935, https://mathshistory.st-andrews.ac.uk/Obituaries/Noether_Emma_Einstein/.
- [7] Nature Editorial, Celebrate the mathematics of Emmy Noether, *Nature* **561** (2018), 149–150, <https://www.nature.com/articles/d41586-018-06658-w>.
- [8] S. Ornes, How close are computers to automating mathematical reasoning?, *Quanta Magazine* (2020), <https://www.quantamagazine.org/how-close-are-computers-to-automating-mathematical-reasoning-20200827/>.