Book Reviews

Math Bytes

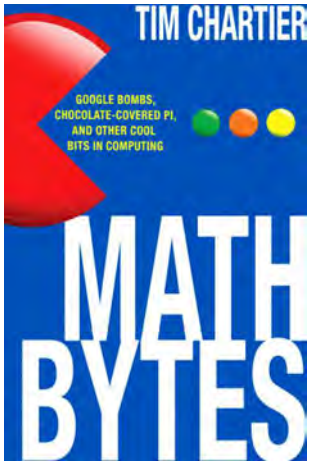
Tim Chartier
Princeton University Press, 2014, ISBN 978-0-69116-060-3

Preliminary remarks

This is possibly the first book I've ever read which could truly be described as a 'gem'. It is a gem in terms of its presentation, its humour, its colourfulness, and its brevity. I have rarely come across a book which crams so many ideas so well into so few pages, and it is full of delights.

The author's aim is to explore the areas where mathematics and computing meet — areas getting larger all the time. I thought of myself as an expert in this area, but even in this short book I found new topics.

A bit more detail



There are 14 chapters, each one about 10 pages long, and handsomely produced in full colour. And there are wonderful examples from popular culture, with a picture of the singer Beyoncé being turned into a Sierpinski triangle, and a maze made in the shape of Bart Simpson. As well as a stylized picture of Barack Obama (used in his 2008 campaign), how to add up random faces to obtain a picture of George Clooney, and how to maximize your score in Angry Birds.

This is designed as a popular text, and so the amount of formal mathematics is relatively small. But the mathematical *ideas* are immense.

The enjoyment of the book would be enhanced by a modicum of computer programming, and if you have some expertise in any programming language, be it high-level like Mathematica or Maple, or low-level like C, you can spend hours programming some of the material (I certainly have). It's a pity that there isn't an accompanying website with programs to download, although the author does obligingly supply a few apps on his personal webpage. One is for approximating a picture by an array of coloured M&Ms. This is the sort of thing a computer is good for: if you tried to use *real* M&Ms you'd end up eating them on the way[1].

[1] You will recognize the voice of experience here.

I had fun with his fractal island, which can be produced with a simple algorithm. Here is how the algorithm is given in the book:

> Start with a square with vertices at $(0,0)$, $(16,0)$, $(16,16)$ and $(0,16)$.
> Now, follow these steps:
> 1. For each line segment (of which there are currently 4) compute the midpoint (x_m, y_m).
> 2. Roll a die, and if you roll
>   - 1-3, let $dx = 2$
>   - 4-6, let $dx = 4$
> 3. Roll the die again, and if you roll
>   - 1-3, keep the dx above
>   - 4-6, change dx to $(-dx)$.
> 4. Repeat steps 2 and 3 to find dy.
> 5. Your new midpoint will be $(x_m + dx, y_m + dy)$.

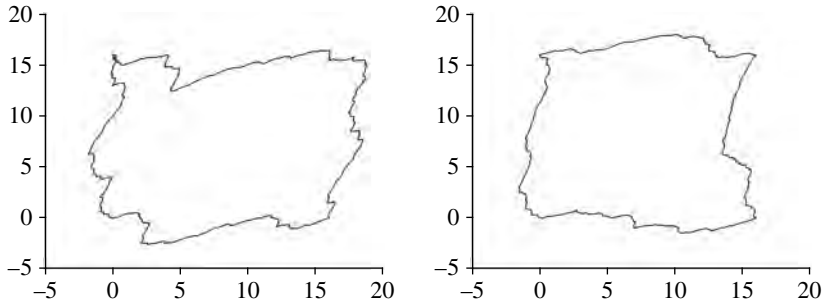
The author intimates by example, without stating it exactly, that at every further step the values of dx and dy are halved. He also recommends that at stage k using as dx and dy a value r chosen randomly to satisfy

$$-\left(\frac{1}{2}\right)^k\left(\frac{7}{10}\right) \le r \le \left(\frac{1}{2}\right)^k\left(\frac{7}{10}\right).$$

This is the sort of thing that's great fun to program. And having written your program, you can explore parameters, like the 7/10 value in the above equation for r, or even the fraction by which the differences dx and dy are adjusted each stage.

Although this might seem a pointless amusement, randomness is a vital element in design. In his 1999 *Digital Typography*, Donald Knuth points out that building a little randomness into a font design gives the resulting shape a little more 'character', and makes it seem a little less clinical.

Just for fun, here are two island shapes I generated, both starting with a square:



We've all seen those remarkable computer-generated scenes with trees, rocks, and all manner of other natural phenomena, but all created using some randomness.

Chapter 9, 'Distorting Reality' starts with a discussion of the 'vanishing leprechaun' whereby a card with 15 leprechauns, cut up and re-assembled in a different order,

has now only 14 leprechauns. (If you want to see this effect without buying or borrowing the book, check out http://britton.disted.camosun.bc.ca/jblep1.htm). This is an old puzzle, and various versions stretch back hundreds of years. If you've never seen it before, the illusion is striking. Chartier shows simply and neatly, with useful diagrams, how the illusion works, and how you can make your own. Then he shows how some simple operations can affect the appearance of an image, and shows some polar warping of Marilyn Monroe, as well as transformations of the colours of an image.

Two other chapters of note: Chapter 11, 'March MATHness' looks at the prediction of winners in the American basketball knockout tournament, which takes off in March. With 64 teams, and 63 to be knocked out, there are

$$2^{63} = 9\,223\,372\,036\,854\,775\,808$$

possible different predictions. This chapter contains a little matrix algebra to demonstrate how to build on 'team strengths', and asks whether it's possible to do better than 63 random guesses. Chapter 12, 'Ranking a Googol of Bits' looks at Google's PageRank algorithm, both informally, and with slightly more depth, again involving matrices and including a quick mention of eigenvectors. This chapter concludes with 'Google Bombs', showing the faces of President George W. Bush, and film-maker Michael Moore.

Conclusions

At only 129 pages (excluding bibliography and index) this book really has something for everybody. I can heartily recommend it to three classes of readers:

1. Mathematics educators, always on the lookout for 'real world' applications to discuss with their students,
2. Students, looking at ways in which mathematics is, and can be, used outside the classroom,
3. Everybody else.

It's a great little book.

Acknowledgments

I am indebted to discussions with Mr Victor Fagundes, at the time a year 10 student from Melbourne Boys High School, who spent a week with me on a work experience, and who read through the book with me and whose insights and perspectives helped me greatly.

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