

example that the perpendicular bisectors of the sides of a cyclic quadrilateral  $ABCD$  are concurrent at the centre of the circle on which the vertices  $A, B, C$  and  $D$  lie; and, further, these perpendicular bisectors divide the quadrilateral up into four smaller quadrilaterals which are also cyclic. There is also a discussion of Ptolemy's Theorem on the product of the diagonals of a cyclic quadrilateral, and the theorem is then used to deduce the sine rule and the addition formulae for  $\sin(a + b)$  and  $\cos(a + b)$ . There is much in this chapter to show senior school pupils something of the beauty of geometry which is so sadly missing from many modern syllabuses.

The author's interest in the history of mathematics is clear throughout the book, and in Chapter 6 the reader is introduced to Christopher Wren and the cycloid, Archimedes' tangrams, an arithmetic textbook written by the 18th century schoolmaster John Mair from Ayr, the statistical diagrams of William Playfair, and the late 19th century study of the flight of a golf ball by Peter Guthrie Tait, who held the chair of Natural Philosophy in Edinburgh while Lord Kelvin held the corresponding chair in Glasgow.

There is a lot of material in this book to interest teachers at all levels. Presentation is very clear throughout, accompanied with lots of diagrams, many of which are in colour. I noticed very few misprints; perhaps one to be pointed out is a missing arrow in the diagram on page 120.

The spread of material is remarkable, showing a wealth of experience and scholarship, and a deep longing to communicate a love of mathematics to the next generation. Teachers can adapt the problems and investigations to suit their needs. I hope the book is well used.

10.1017/mag.2024.136 © The Authors, 2024

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**Victorians & numbers** by Lawrence Goldman, pp. 448, £35 (hard), ISBN 978-0-19284-774-4, Oxford University Press (2022)

The catch-phrase of Charles Dickens's Mr Gradgrind was "Now, what I want is, Facts." That arch-villain of *Hard Times* is usually taken to represent simple Utilitarianism, but Lawrence Goldman shows us that Gradgrind, like his predecessor Mr Slug of the Mudfog Association, actually encapsulates Dickens's mistrust of the growth of statistics in the first half of the nineteenth century.

Any state concerned about its finances needs to have some idea of its population and their needs, so there is no question of statistics in Britain starting with the Victorians. (Indeed, the book's title is somewhat inaccurate; the Statistical Society of London was founded in 1834 in response to an already growing systemisation of data collection, and Goldman gives considerable space to the years before 1837.) Political Arithmetic had been systematised in German states in the eighteenth century; *Statistik* was related to the creation and administration of the state (*Staat*), and that is the etymology of the modern word. Goldman identifies the catalyst for the growth of statistics in the expansion of the State since the 1790s, coupled with the reform of Britain's political and governmental institutions and the political crisis of the late 1820s. There was a perception that the state had insufficient data about the country's economy and society. The General Register Office (now the Office for National Statistics) was formed in 1837 for the simple enough purpose of registering all births, deaths and marriages, a task previously carried out at a parish level and which thereby confined dissenting communities to

limbo, while the complexities of voter registration required by the reformed Parliament added to the need for more accurate data about the population. (Voter registration became an even hotter issue after the Second Reform Act of 1867.) The Board of Trade established a Statistical Department in 1832, but in 1853 Northcote and Trevelyan recommended that its duties be devolved to separate government departments, and this allowed the Statistical Society of London to become a figurehead.

It is characteristic of the difference between Germany and Britain that *Statistik* was the province of university professors, while the accumulation of data and decisions as to what to do with it were done in Britain largely by the non-academic governing or commercial classes. There was a feeling that its purpose was not merely descriptive but the improvement of the general welfare. Jeremy Bentham was one of many who supported the organisation of a statistical society to provide justification for the wholesale reform of British institutions; but in due course those who upheld the *status quo* also learnt how to quote statistics for their own purposes. For example, mill owners would use data to show, so they claimed, that conditions inside their mills were no worse than outside, even when Marx and Engels would admire the detail and availability of the data with which they constructed their own theories.

Another aspect of the increasing importance of data is found in criticisms, emanating largely from Cambridge in the 1820s and 1830s, of early political economics, and in particular that of David Ricardo. *Principles of Political Economy* uses a traditionally Aristotelian approach, making deductions from what Ricardo claimed were obviously true axioms. But critics argued that such axioms were highly dubious, especially as they were not founded on data. (The argument over the validity of deductive economics continues to this day, with doubts expressed over the validity of the highly sophisticated mathematical tools used in, for example, econometrics.) Ricardo's approach, so his critics said, needed to be replaced by an inductive method based on empirical results.

After some introductory chapters, Goldman's book is organised by personalities. (Just why it is necessary to number the first 47 pages of text with roman numbers, so that page 1 is about one-eighth of the way through the substantive text and the final page number is misleading as to the length of the book, escapes me.) There are chapters on Babbage and Lovelace, Richard Jones and William Whewell, the great Belgian Adolphe Quetelet (whose influence was as great as his reputation), William Farr, and Henry Thomas Buckle, among others. Nearly fifty pages are devoted to Francis Galton, giving due attention to his now unacceptable advocacy of eugenics, but emphasising that he initiated techniques of mathematical statistics that allowed proper conclusions to be drawn from data that to previous generations could be treated only in a qualitative way. Goldman is a distinguished social and political historian (Sir Christopher Clark, in *Revolutionary Spring* [pp. 24, 724-725], cites him as the authority for his own mention of the growth of political statistics and the central role of Quetelet). But he makes no claims to mathematical knowledge, and indeed *Gazette* readers will observe over-simplifications and inaccurate terminology that reduce confidence in some of his other technical assertions.

To me the most thought-provoking aspect of the book was the recurring mention of misuses of statistics, or doubts cast on its validity. A whole chapter is entitled 'The Opposition to Statistics: Disraeli, Dickens, Ruskin and Carlyle'; the last three writers emphasised, emotively, the meaninglessness of statistics in the experience of

suffering individuals\*. At the International Remuneration Conference of 1885, representatives of the workers were angered at claims that they were better off than ever, saying that this was contradicted by their personal experience. Goldman argues that such cases proved the limitations of working only with measures of central tendency, and it was Galton's introduction of standard deviation as a measure of variation that allowed the more marginalised to be better treated. Towards the end Goldman considers two competing conceptualisations of data, either as simple descriptors free of the biases of conjecture or theory, or as embodying by their choice and deployment the mindset and intent of those who use them. (The latter is characteristic of a mindset, even an orthodoxy in some circles, that views the collection of data, like the creation of maps and even general interest in other civilisations—cf. Said's *Orientalism*—as an assertion of supremacy.) He then says,

The argument of this book ... is that numbers are plastic and malleable, tools to be used for good or ill, whose essence cannot be captured by this kind of binary division.

I can't say that I have been very convinced by the author's argument—indeed, I am not sure that it goes much beyond presentation of the different uses. The book as a whole is obviously researched to high academic standards and it is very well produced (though the author's punctuation could sometimes be clarified). But at the end of it I was unconvinced that I had learnt much of vital historical or statistical significance—much, that is, that goes beyond the merely interesting. More crucially, my lasting impression was that statistics used for social or political purposes still retains plenty of problems for the non-specialist populace, and that is a matter that should concern all professional statisticians.

10.1017/mag.2024.137 © The Authors, 2024

Published by Cambridge University Press

on behalf of The Mathematical Association

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**The story of proof: logic and the history of mathematics** by John Stillwell, pp 442, £38, ISBN 978-0-69123-6437-3, Princeton University Press (2022)

There are many books on the history of mathematics, a few of which focus on proof, but what this remarkable piece of writing sets out to do is show how *essential* the process of proving is to the development of the subject. As a result the book has an enormous *range*—from Euclid to the current day—and a *seriousness* which makes it both a delight and a challenge. It is not an easy read, and the author is never going to descend to the level of a 'history of mathematics' which I read recently which inserted flippant footnotes of the 'You're just going to have to believe me' type whenever the going got tough.

Its fundamental thesis is that any branch of mathematics sets out with problems which require a new realm of *objects* and a battery of new techniques for using them. An illustrative example of this is the use of infinitesimals for calculating areas and gradients of curves using infinite geometrical processes and

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\* But Raymond Williams, in a famous book, said that while Dickens "turned his mocking invective" on "the procedure of systematic enquiry, ... Carlyle makes no such trivial error. He criticises imperfect statistics, but his demand, rightly, is for the evidence, for rational enquiry." [*Culture and Society* (1958), Part 1, chapter 4]