human experiences we all go through: pain, joy, expectancy, desire, disease and, looming behind all these, the inevitability of ever-approaching death. ■

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Numerical concoctions

Once Upon a Number: The Hidden Mathematical Logic of Stories
by John Allen Paulos
Penguin: 1999. 214 pp. £12.99, $23 (hbk)

Jeremy Gray

Sadly, we do not make our way through life the way professors of statistics, or of any other science, would have us do. Outside the classroom, most of us, most of the time, make elementary errors when reasoning about probabilities. Juries fail to give equal weight to all the evidence and cling obstinately to just those facts that suit their purposes; lawyers have been known to mislead juries over the interpretation of DNA evidence; psychics do well, though doing no better than chance; fraudsters separate the credulous from their money.

To his credit, John Allen Paulos, a mathematician at Temple University in Philadelphia, would not address these problems by herding us all back to school or college. He thinks the problem lies in the way we build up the stories we use to get us through life, the explanations we concoct and the way we feed quantifiable information into the mix. In this book he wanders around the issue, hoping to shed what even he calls an oblique light on the matter.

Sometimes the issue is straightforward; seemingly very rare occurrences, in fact, crop up all the time. We have a bias towards blaming people when someone is injured, but saying it was only bad luck when an exactly similar mistake injures no one. In such cases, our prior views about the way the world operates twist our use of the numbers.

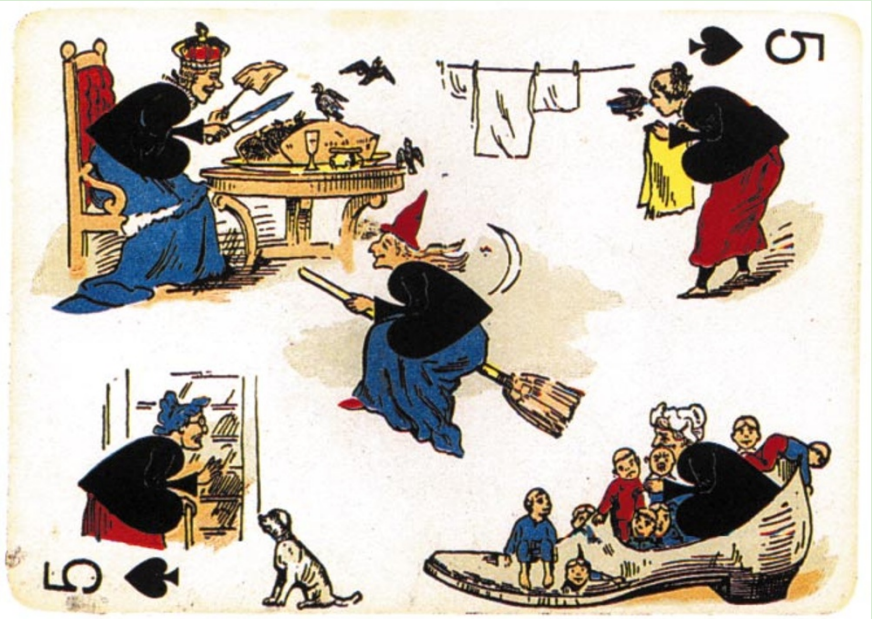
Everyone uses rules of thumb to deal with the complexities of real life. These may have something going for them, even if they wouldn't get good marks on a statistics course, because they allow us to filter out the complexity. Here, however, the author may not appreciate the scale of the problem. At one point Paulos jokes (and the book is full of jokes, some of them very funny) that the typical statistics problem vexes thousands and pleases seven or eight. In fact, most of his examples are contrived in this possibly vexatious way. This is partly because Paulos is writing a popular book in which the arithmetic must be made easy and the assumptions kept simple. But it is partly a function of the way statisticians operate, because the complexities of real life are daunting. The end result, nonetheless, is hypothetical situations that are too simple to convince us that their statistical morals apply to real life, and it is not always clear that Paulos realizes this.

Statistics is not the only discipline to take a toy fishing-net to the ocean. The second half of the book is at least as interested in the disparity between simplified pure logic and the ways we reason, which various novel accounts of logic attempt to describe. Paulos mentions situational logic in this context. He also considers the complexity of the world, describing how complexity theorists think about it; he alludes to Ramsey theory, and generally discusses how order and simplicity always seem to turn up somewhere.

These are important issues, and the reader who does not know of this work will be amused and diverted. But the claim that this connects to our use of stories is a tenuous one. It is not that anything Paulos says is wrong, so much as that everything he says is superficial. There are deep problems here about order, chaos and complexity, on the one hand, and how our mind works, on the other, but on the evidence presented here we are very far from putting the two together.

Paulos intends the term 'story' to mean more than just the little analyses we make up for ourselves. He wants it to reach as far as published stories, from romantic and detective fiction to the profundities of Anton Chekhov. There is nothing here that will help the reader enjoy fiction more, read it more carefully or understand how it works. We are indeed dangerously close to the literal-minded approach to fiction so ruthlessly parodied under the heading, "How many children had Lady Macbeth?".

The book comes nowhere close to living up to its subtitle. It does not provide a mathematical logic for stories, but merely suggests that intentional logic addresses the issue of finding meanings in the confusing world around us. It does convey a good sense of the difficult nature of that task, at which humans manage to be remarkably good while being in some basic ways rather bad. There is probably somewhere an automatic theorem-proving machine that can outstrip most of us at solving puzzles of a logical or probabilistic kind. But if so, that would only prove yet again that computers can do some things very much better than we can, and still can't think. Resolving this conundrum will help us understand how the mind works. Until then,



Playing with numbers

It may look like a nursery rhyme montage, but the illustration above is actually the five of spades from a surreal pack of playing cards. The challenge in producing such 'transformation' cards lies in intriguing the eye with some kind of visual pun or surprise while minimizing the element of distraction from the card's suit and value. The first such playing cards were produced in Germany in 1801, and pictorial themes have since ranged from the satiric and comic to the erotic and commemorative. Illustrations of other transformation cards form just one feature among the many tantalizing images to be found in *The Playful Eye: An Album of Visual Delight* edited by Julian Rothenstein and Mel Gooding (Redstone, £19.95; pbk), a collection of popular graphics of the nineteenth and early twentieth centuries.

books like this one will tell us, very enjoyably, that there is work to be done. ■

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More on numbers

What is Random? Chance and Order in Mathematics and Life
by Edward Beltrami
Springer, $22, £15.50

Imaginary Numbers: An Anthology of Marvelous Mathematical Stories, Diversions, Poems, and Musings
edited by William Frucht
Wiley, $27.95, £22.50

New in paperback

Constructing Quarks: A Sociological History of Particle Physics
by Andrew Pickering
University of Chicago Press, $26, £18.50

Great Feuds in Science: Ten of the Liveliest Disputes Ever
by Hal Hellman
Wiley, $15.95, £9.99

Science As A Way of Knowing: The Foundations of Modern Biology
by John A. Moore
Harvard University Press, $18.95, £11.95

Warmth Disperses and Time Passes: The History of Heat
by Hans Christian von Baeyer
Random House, $13.95, £11.99

The Gospel of Germs: Men, Women and the Microbe in Modern Life
by Nancy Tomes
Harvard University Press, $16.95, £10.50

Making Sense of Illness: Science, Society and Disease
by Robert A. Aronowitz
Cambridge University Press, £11.95, $29.95

Nature Wars: People Vs. Pests
by Mark L. Winston
Harvard University Press, $15.95, £9.95

The Handicap Principle: A Missing Piece of Darwin's Puzzle
by Amotz & Avishag Zahavi
Oxford University Press, £11.99, $16.95

Consilience: The Unity of Knowledge
by Edward O. Wilson
Abacus, £8.99, $14

The Woman That Never Evolved
by Sarah Blaffer Hrdy
Harvard University Press, $16.95, £10.50

Social Mindscapes: An Invitation to Cognitive Sociology
by Eviatar Zerubavel
Harvard University Press, $15.95, £9.95

Blind Watchers of the Sky
by Rocky Kolb
Oxford University Press, £8.99

The Anti-Depressant Era
by David Healy
Harvard University Press, $17.95, £10.95

Light from underground

Mosaic Evolution of Subterranean Mammals: Regression, Progression and Global Convergence
by Eviatar Nevo
Oxford University Press: 1999. 413 pp. £95, $175

Hynek Burda

Across the globe, at least 285 of 4,629 species of mammals, representing 11 families, spend most of their lives in moist, dark, oxygen-poor and carbon-dioxide-rich burrows, deprived of most of the sensory cues available above ground. These mammals have become fully specialized for a unique way of life in which foraging, mating and breeding take place underground.

Although most subterranean species have been known to scientists for a long time, their biology has remained largely unstudied. This may be explained by their cryptic way of life and the related problems of keeping, breeding and monitoring them, and also by the fact that scientists tend to be more attracted by animals confronting environments and problems above ground that seem far more complex than those encountered below ground (sensitive vision compared with blindness, echolocation compared with human-like hearing, long-distance navigation/maze orientation across tens of metres, thermoregulation in the cold/life in a thermally buffered burrow). Although many specimens of moles (insectivorous subterranean mammals) and mole-rats (subterranean rodents) have been deposited in museums, not even the morphology of their digging specializations has received the attention it deserves. The convergent evolution of subterranean mammals, one of the most remarkable examples of convergence, is rarely mentioned in textbooks.

The 'sleeping beauty' of subterranean mammals, and their importance for science, has been awoken by Eviatar Nevo of the University of Haifa, Israel. His contribution to the growth of our knowledge of subterranean mammals has not only inspired others; he has himself co-authored at least 20 per cent of all published studies.

Growing knowledge, and the landmark dates of Nevo's major contributions (1969, 1979, 1989), seemed to predestine 1999 as a further important year, and the time was right for his book to appear. Undoubtedly, Nevo is the most competent person to write it. And the expected monograph, which went unpublished for several decades, has at last appeared.

The book describes and analyses the 40 million years of global evolution of subterranean mammals and its implications throughout biology. Although the underground habitat is in many respects relatively simple, monotonous, stable and predictable, it is in others very specialized and stressful. Consequently, the evolution of subterranean mammals involves dramatic and complex adaptive structural and functional changes that are both regressive (degenerative) and progressive (compensatory). This mosaic convergent global evolution of subterranean mammals is an example *par excellence* of comparative studies in evolution at all organizational levels, from the molecular to the organismal, oriented by natural selection.

The book is filled with information. The reader will find not only an up-to-date overview of subterranean mammals and their evolutionary problems, but also detailed information and references to general aspects of sensory and behavioural ecology, morphology, physiology, genetics and immunogenetics. This is all based on Nevo's 50 years of studies and experience, and on careful, critical and thoughtful study of hundreds of articles and books. The book provides excellent texts for seminars and courses. It is richly illustrated, and there are more than 1,800 entries in both the index and the well-balanced bibliography. The book is a 'must' for all students of subterranean mammals, and will be very useful to evolutionary biologists.

Considering the hitherto catalytic effects of Nevo's work, I would like to bet that the number of studies dealing with subterranean mammals will rise dramatically in the coming years (indeed, there is great potential for surprising discoveries), and that there will quickly be a need for a second edition. No doubt, subterranean mammals will soon be burrowing their way into the textbooks of the future. ■

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