Reviews

The man from the future by Ananyo Bhattacharya, pp 368, £10.99 (paper), ISBN 978-0-24139-886-9, Penguin Books (2022)

This is a splendid biography of the legendary genius John von Neumann (1903-1957) who made enormous contributions in his life-time across virtually every area of cutting-edge science. After the opening chapter 'Made in Budapest' there are seven more chapters on the man's astonishing achievements. These include mathematical logic, the foundation of quantum mechanics, the development of the modern computer, game theory, economics, the theory of replicators, and, amidst all these, his significant contribution to the Manhattan Project, the development of the atomic bomb for the American government, some of which remains classified. Without resorting to a single equation in the whole text, the author sets out the fascinating and compelling material skilfully. Clarity, deftness and well-chosen phrases bring back the excitement of the decades concerned, together with comments of current relevance. Each of these diverse subjects is very well explained, with sufficient technical details to satisfy even readers already familiar with the topics concerned.

Scientists who had influenced von Neumann, or been influenced by him, form a star-studded list; his contemporaries said of him that whereas "mathematicians prove what they can, von Neumann proves what he wants". There are dozens of original ideas coming from the man himself: definition of numbers, his algebra, the development of the ENIAC computer, Monte Carlo methods of simulation, optimisation methods, linear programming, system analysis, and his 'probes' (self-replicating spacecrafts). He invented the simple method of generating pseudorandom numbers by squaring a four-digit number, taking the middle four digits, and repeating the process, which was good enough for his purposes even though he knew that 'anyone who considers arithmetical methods of producing random digits is, of course, in a state of sin'. Apparently his wife Klára was the first person to write and implement programs with stand-alone subroutines. Nowadays computers run Monte Carlo simulations countless times each day, with diverse applications ranging from optimising stock portfolios to the factorisation of integers.

Von Neumann is famous for being the creator of the theory of games, with applications in social and economic affairs, not to mention strategies in warfare. His proof of the minimax theorem and the analysis of two-person zero-sum games that necessarily have a solution that is either a pure or a mixed strategy is now so standard that the term 'zero-sum' has become common parlance. Half a dozen Nobel laureates are reckoned to have been influenced by this work, among them Kenneth Arrow for his work on the theory of general equilibrium which models the working of a free-market economy, and John Nash who used his fixed-point theorem to establish key results in economics. I first came across the name von Neumann as a graduate student at the poker-table with smart players in the 1960s. "We are not bluffing often enough!" muttered Ken Binmore who had been extolling all evening the wisdom in *Theory of Games and Economic Behaviour* by von Neumann and Oskar Morgenstern. "Shut up and deal" was the reply from Alan Camina and Fred Piper, and we all moved on. I realised that Ken had meant business only when 'Poker and Bluffing" was part of one of his courses when he held the chair of mathematics at the London School of Economics. By 2000, Ken Binmore had become widely known as the 'poker-playing economic theorist' who led the team that designed the 3G telecommunications auction that netted the British government £22bn. Who says there is no serious money in the study of mathematics?

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Subsequently the 'rational players' in game theory have given way to evolutionary strategies and natural selection, and the subject has since been applied more widely and controversially to explain various social interactions between humans, from mating strategies of males and females to the evolution of language.

Von Neumann regarded his work on automata as the crowning achievement of his later years, and his close friend Stanlislaw Ulam says that the theory of replicating machines was, along with his other contributions to computing, his 'most permanent, most valuable, most interesting work'. The project would link up his early interest in logic with his later work on neurophysiology and on computers, with the prospect of profound contributions to all three fields. That he did not live to complete his program in automata theory is a big loss to science, although his legacy has worthy successors such as John Conway with his game of 'Life' and, more recently, Stephen Wolfram's own theory of automata.

There are many stories of prodigies and their feats, but only very few are in von Neumann's class. The brash teenager had the nerve to call on David Hilbert at Göttingen to have his say, and he was well treated and taken very seriously. As a young colleague of Albert Einstein and Kurt Gödel at Princeton, he made such a significant contribution that they even tolerated the full blast of Hungarian music from his office. Cancer came at a particularly cruel time, and he was hospitalised for most of his last year. Tactfulness was never Gödel's strong suit so, in his letter offering condolences, he also wrote 'about a mathematical problem, on which your opinion would very much interest me ...', and launched into the description of a Turing machine, proposing what is now known as the P versus NP problem which would only be rigorously formulated much later and which has become the most famous unsolved problem in complexity theory. By this time Klàra was answering most of his correspondence, and it is not known if von Neumann even saw the letter.

As a six-year-old boy, von Neumann was reputed to be able to multiply two eight-digit numbers mentally. Now his beloved daughter Marina had to leave his hospital room in tears when he was asked to give the sum of two single-digit numbers. Throughout his life, his hatred of both the Nazis and the totalitarian Soviet Union meant that he had no qualms with work on weapons of mass destruction, with the death of people in possibly millions. He now became bewildered and angry with the anticipation of his own untimely demise. To the dismay of his friends and colleagues, he accepted Pascal's wager and returned to Catholicism in his last weeks. It seems appropriate to sum up the man from the last page of Klàra's unfinished memoir: 'I would like to tell about the man, the strange contradictory and controversial person; childish and good-humoured, sophisticated and savage, brilliantly clever yet with a very limited, almost primitive lack of ability to handle emotions—an enigma of nature that will have to remain unresolved'.

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Luck, logic and white lies, the mathematics of games by Jorg Bewersdorff, pp. 568, £42.99 (paper), ISBN 978-0-36754-841-4, CRC/Taylor and Francis (2021)

Writing books on the mathematics of games and gambling has a long tradition. One of the earliest tracts on probability theory, Pierre de Montmort's *Essai d'analyse sur les jeux de hazards* (1708/14), develops probabilistic notions using problems arising in