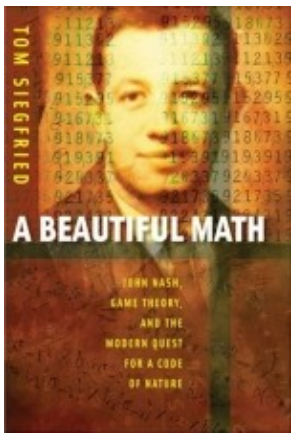
June 2007
Reviews

# 'A beautiful math'

## reviewed by Lewis Dartnell




## A beautiful math: John Nash, game theory, and the modern quest for a code of nature

## By Tom Siegfried

Sylvia Nasar told the story of John Nash's troubled life in her book *A Beautiful Mind*, although probably better known as the film with Russel Crowe. Neither really explored the beauty of Nash's maths, however, and why his advances in game theory were so powerfully important to so many disparate fields of research and earned him a Nobel prize in 1994. Tom Siegfried sets out to address this unbalance in *A Beautiful Math*. He does so superbly, explaining how Nash did for the biological and social universes what Newton and Einstein accomplished for the physical universe.

Siegfried devotes a healthy proportion of the book placing Nash's contributions into their historical context. He shows the development of economic and evolutionary theories by people like Adam Smith and Charles Darwin, and the growth of research into optimal strategies that operatives can use when interacting with each other, now come to be called *game theory*. An early result was the proof that in any two−person game where what one player gains the other loses (a so called *zero−sum* game, such as chess) it is always possible to find a best strategy for both players (although that best strategy may well involve randomly selecting between

different actions each play). But despite this brilliant insight by John von Neumann and others, game theory was still too limited to be meaningfully applied to real−world strategic situations.

The problem is that most real systems, such as social or political manoeuvrings, international relations, or microeconomics, are fabulously complex with networks of dependencies and interactions between individuals. In reality, the games of life are played with vastly more than two players, and there is always the opportunity to actually co−operate with others for mutual benefit. No decision is made in isolation, but is influenced by the expectations of everyone else's decision "I think that he thinks I think...", and so on. That was until John Nash came onto the scene.

Nash developed the mathematics to prove that for any game with any number of players, there could always be found a special balancing point, the *Nash equilibrium*, whereby everybody is content with their lot and could not reasonably hope for a better outcome. *A Beautiful Math* gives a rich account of all the areas of study that Nash's work came to revolutionise, from military strategic analysis during the Cold War to economics, animal behaviour, evolutionary biology, human behaviour, psychology, neuroscience and sociology. But this is not simply a history book. After giving a solid review of the development of applications of this Beautiful Math, Siegfried turns his attention to the future of game theory, including plans to incorporate the weirdness of quantum mechanics into game strategies. Siegfried also makes a good effort at explaining the links between group behaviour and physics, such as why some researchers talk about "taking the temperature of society" or "sociomagnetism".

A major drive through the history of science has been to develop a "Code of Nature" an understanding of the interactions of humans and society, and Siegfried thinks that game theory might just be the perfect toolkit. But one problem with applying game theory to animal behaviour or human psychology is that individuals often seem to follow strategies very different to the Nash optimum. With limited time and brain power to make an important decision, actually working out your optimum strategy under the Nash equilibrium could be extremely difficult, and at the end of the day not worth the slight improvement in outcome over simpler strategies. Furthermore, more and more psychology experiments are showing that humans often behave very irrationally, such as choosing to punish a cheater in a game even to their own detriment.

This is a very far−reaching book indeed, but Siegfried is careful not to lose his readers along the way. *A Beautiful Math* is written in a light and conversational style, interspersed with quotes from conversations the author has had with some of the key modern researchers, and with plenty of notes at the back containing more detailed discussions or references if you want to follow up on a particular point. The actual algebra used to calculate the players' optimum strategies at Nash equilibrium is neatly tucked away in the Appendix to leave the text of the chapters uncluttered and readable. This is a well−needed book to complete the story of Nash and his continuing influence in the modern world, because, to borrow Siegfried's flowing words, game theory explains "the coexistence of selfishness and sympathy, competition and co−operation, war and peace".

***Book details:***

*A beautiful math*
Tom Siegfried
hardback − 264 pages (2006)
Henry (Joseph) Press
ISBN−10: 0309101921
ISBN−13: 978−0309101929

# About the author

Lewis Dartnell read Biological Sciences at Queen's College, Oxford. He is now on a four−year combined MRes−PhD program in Modelling Biological Complexity at University College London's Centre for multidisciplinary science, Centre for Mathematics &Physics in the Life Sciences and Experimental Biology (CoMPLEX). He is researching in the field of astrobiology  using computer models of the radiation levels on Mars to predict where life could possibly be surviving near the surface, as recently reported in the news.

He has won four national communication prizes, including in the Daily Telegraph/BASF Young Science Writer Awards. His popular science book, *Life in the Universe: A Beginner's Guide*, is published by Oneworld Publications. You can read more of Lewis' work at his website.

---

*Plus* is part of the family of activities in the Millennium Mathematics Project, which also includes the NRICH and MOTIVATE sites.