

BOOKS & ARTS

Social science goes virtual

Mathematical models could help us re-engage with reality rather than trying to reinvent it.

Complex Adaptive Systems: An Introduction to Computational Models of Social Life

by John H. Miller & Scott E. Page
Princeton University Press: 2007. 284 pp.
\$24.95, £14.95 (pbk); \$65.00, £38.95 (hbk)

Generative Social Science: Studies in Agent Based Computational Modeling

by Joshua M. Epstein
Princeton University Press: 2007. 352 pp.
\$49.50, £29.95

Philip Ball

The idea that the social sciences have anything to learn from the physical sciences has raised many hackles. Some social scientists suggest that to use particle-like models of 'agents' that interact via simple rules to explore the emergence of complex collective behaviour is to neglect the sociologist's obligation to explain why individuals behave the way they do. Ironically, this position displays a curious indifference to the 'social' aspects of life. In his recent book *The Flight from Reality in the Human Sciences* (Princeton Univ. Press, 2005), political scientist Ian Shapiro lamented what might be called the 'physicization' of social science. He claimed that mathematical models that mimic physics fail to engage with the political landscape of the real world and instead disgorge "stylized facts that turn out on close inspection not to bear much relationship to any political reality".

At face value, *Complex Adaptive Systems* by John Miller and Scott Page and *Generative Social Science* by Joshua Epstein seem to encapsulate all that Shapiro deplors, but in reality they are part of the solution, not the problem. Shapiro's complaint hinges on the way social scientists have embraced models taken from economics, which themselves emulate physics. This qualifier is in fact the central issue, which Miller and Page examine in illuminating detail. As Shapiro puts it, economic theory has developed "a perverse sense of rigor, where the dread of being thought insufficiently scientific spawns a fear of not flying among young scholars". The result is that the models take no account of real human behaviour, which is far too messy to permit any theorems that can be proved rigorously. So economic models become citadels of crystalline mathematical perfection that would shatter if touched by the harsh rays of reality.

It would be grossly unfair to suggest that this describes everything that happens in eco-



Computer simulations probe how the Anasazi culture spread in the American southwest.

nomics, let alone in all social sciences. But it is widespread, and is reflected in Miller and Page's comment that economists are scandalized to discover how cavalier physicists are in making conjectures that lack any fundamental justification. The irony is that some of the foundational aspects of statistical physics, which provided economists with the early conceptual framework for the neoclassical theory of market equilibrium, remain unproven in any rigorous mathematical sense.

It is absurd that a science as complicated and ill-posed as economics should demand a degree of rigour that not even physics enjoys. That's why these two books are part of an important trend in the social sciences. Both argue for the value of agent-based modelling (ABM) in social science. This approach involves "growing societies from the bottom up", as Epstein has put it, rather than devising analytically airtight theorems from first principles that are tractable but transparently wrong in what they assume and imply about human behaviour.

The aim of ABM is to study whether the macroscopic patterns or regularities that we observe in society, such as price equilibria or the appearance of behavioural norms, can be generated from decentralized, local interactions between collections of agents.

Epstein's book is a collection of papers that use this approach to explore phenomena as diverse as civil violence, retirement, the emer-

gence of classes and the spread of epidemics. His classic example is the modelling of the demographics of the Anasazi culture of the American southwest between AD 800 and 1300 on the basis of archaeological evidence. Miller and Page, meanwhile, aim to outline a general programme of what ABM is and how it might be conducted. Both books show that computational modelling is slowly beginning to take root in the social sciences. Economics, however, continues largely to resist the idea, as it is incompatible with the standard assumption that the economic system is at equilibrium.

ABM gives access to virtual worlds that rigorous theory cannot touch. In these worlds the actors may differ; they have access to limited, mostly local, information and are limited in their ability to use it; they learn from experience, make mistakes, switch allegiances and copy others. No one should mistake these realms for our own, but they certainly sound closer to it than the neoclassical model of identical rationalizing agents, in which there often seems to be no populations with sizes between two and infinity.

Newcomers to this field might nevertheless find the degree of abstraction unnerving. They might ask, for example, whether Epstein's ring of agents making binary choices based on majority polling of their neighbours, or the forest-fire models presented by Miller and Page, could possibly map onto a real social situation. Aren't

these just offering vague metaphors of untested relevance? Indeed, if I have a criticism of Miller and Page, it is that they don't sufficiently address the fearsome question of how such testing might be done. This is discussed in some detail in Scott de Marchi's *Computational and Mathematical Modeling in the Social Sciences* (Cambridge Univ. Press, 2005). But in any event, that isn't really the point. Shapiro suggests that the role of political theorists is to rove the political landscape "debunking myths and misunderstandings that shape political practice". Properly applied, ABM might do just that.

The famous segregation model of economist Thomas Schelling, who pioneered the

ABM approach in the 1970s, showed that a high degree of social segregation does not, as one might assume, imply extreme intolerance. Conversely, and relevant to today's political climate, it showed that a combination of mobility and choice may amplify marginal preferences or imbalances into major social divisions. Agent-based models may not describe reality, but they can show how interaction and nonlinearity produce social outcomes that could not be predicted simply by inspecting the behavioural rules. They undermine the common political presumption that group behaviour is a multiplied version of individual behaviour. They expose how ideas such as market efficiency may

mutate from predictions of simplistic theories into dogmas that are applied insistently to the real economy. They might not tell us why certain social phenomena happen, but they offer mechanisms for how they might.

The challenge, which cannot be over-emphasized, is to ensure that ABM does not get above its station. It is a tool, not just another method for imprinting belief and prejudice with the false authority of 'theory'. As such, these models could form part of a toolbox that helps social scientists to re-engage with reality rather than trying to reinvent it. ■

Philip Ball is author of *Critical Mass* and a consultant editor for *Nature*.

In the eye of the storm

Storm World: Hurricanes, Politics, and the Battle Over Global Warming

by Chris Mooney

Harcourt: July 2007. 392 pp. \$26

James Elsner

Chris Mooney's follow-up to his *The Republican War on Science* (Basic Books, 2005) is a reconnaissance flight into the turbulent debate over a link between hurricane activity and global warming. The flight log is compelling enough for Hollywood. It records a clash between the empiricist climate scientist William Gray (think Ian McKellen) at Colorado State University and the theoretician Kerry Emanuel (think Tom Hanks) at the Massachusetts Institute of Technology. Journalist Mooney has a scriptwriter's flair for pitting his protagonists against each other and dishing the historical and methodological back story in vivid prose: "If we're really making the deadliest storms on Earth still deadlier, it will represent one of humanity's all-time greatest foot-shooting episodes."

The debate swirls about the cause of the

recent upswing in severe hurricanes, especially over the Atlantic where evidence for a change is most compelling. Warmer tropical oceans will increase the potential intensity of tropical cyclones, but for Gray the causal chain ends with the ocean. "Nobody knows how the atmosphere works," he says, feeling that it is far too complicated to be captured by a computer. Emanuel, on the other hand, adds a further link to the chain, placing the blame on human meddling with the composition of the atmosphere.

Just a month before Hurricane Katrina's devastating strike on America's south coast on 29 August 2005, Emanuel published a paper in this journal (*Nature* **436**, 686–688; 2005) that ignited a scientific debate by linking storm strength to ocean temperatures. It also triggered a maelstrom of media coverage that resulted in the US National Oceanic and Atmospheric Administration (NOAA) closing ranks and claiming unequivocally that the increase in Atlantic hurricane activity since 1995 could be attributed solely to an ocean cycle unrelated to greenhouse warming. Mooney is at his best when describing

this sort of political tempest. By allowing what Emanuel calls the "party line" while discouraging dissenters, NOAA was, in Mooney's words, "gaming the release of information and trying to shift the debate in their favoured direction".

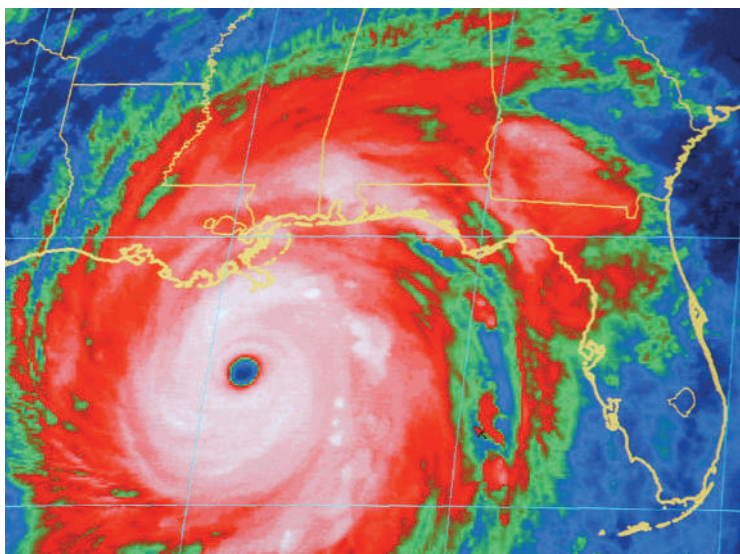
Mooney revisits his call, propounded in his earlier book and in subsequent newspaper and magazine columns, for scientists to do a better job of communicating science to the public and media. He urges researchers to stop pretending that they are nothing but objective "fact machines" and to instead give more general interpretations of their results and put them into a broader context.

Drawing on scientific conferences and on interviews with hurricane and climate scientists during 2006, Mooney covers plenty of ground, from heat engines and synoptic meteorology to computer modelling, and all without equations. At times *Storm World* feels hurried, US-centric and somewhat uneven, jumping between history, science and politics. But Mooney presents an accurate account of the clash between two of the most prominent climate scientists today. He is a good writer — "Scientists, like hurricanes, do extraordinary things at high wind speeds" — and his stories are consistently about people, giving the book a wide appeal.

In the end, he does give a clear picture of what the hurricane-climate change debate is about and where it might go next. As there are no answers, the book provides none. Not surprisingly, Mooney takes a liking to Gray, but cannot recommend his view that global warming has nothing to do with hurricane activity. Amusingly, Mooney also implies that, for storm climatologists, science sometimes plays second fiddle to entertaining soundbites.

Many scientists are contributing to one of the most important climate debates in history. Neither side is completely wrong and both would do well to study the full breadth of literature, to which *Storm World* is a useful addition. It's a great summer read, while the story continues. Let's hope there are more answers in the sequel. ■

James Elsner is a professor of geography at Florida State University, Tallahassee, Florida 32306, USA.



Debate swirls about the recent upswing in severe hurricanes such as Katrina.

NOAA/AP