Beat the cycle of preference

The power of mathematics to cut across disciplinary boundaries seems almost unlimited. By some quirk of mathematical logic, the Schrödinger equation — with imaginary time — can offer an elegant description of an evolving biological population. Differential geometry has been fruitfully applied to finding the right price for financial products. Surprisingly, ideas from mathematical physics may even tell us something about the nature of democracy, and its inherent pitfalls.

In the eighteenth century, the French philosopher the Marquis de Condorcet proved a disconcerting theorem about public opinion. As individuals, people tend to be logically consistent in their opinions or preferences. If, in the current campaign for the US Presidency, I prefer Obama over Clinton, and Clinton over Romney, then I'll also prefer Obama over Romney. If A outranks B, and B outranks C, then A should outrank C. Most of our thinking conforms to this basic rule of logic.

But just because individuals follow such logic, this doesn't imply that groups do. Within a population of people, Condorcet proved, it is possible for a majority to prefer A over B, a majority to prefer B over C, and a majority also to prefer C over A — making a cycle of collective preference, so that it's impossible to say which the people really prefer. Indeed, they may well have no clear preference.

Condorcet's proof of principle doesn't establish that cycles really exist, but more recent analyses, based on statistical mechanics, suggest that it's likely. Suppose that individuals within a large population rank a series of alternatives, A, B, C… in random order, independently of one another. In this context, physicists Matteo Marsili and Giacomo Rafaelli asked, what is the chance, mathematically, that you'll find cycles in the group preferences when these people vote on the various alternatives in pairs? Their results showed that as the number of alternatives becomes large, the chance of having cycles rapidly approaches one (www.arxiv.org/abs/cond-mat/0403030).

This suggests — within the limitations of the random-preference approximation — that the trouble presented by cycles may indeed be real. (One caveat: the work also suggests that the human tendency

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towards conformism may lead many people to similar preferences, thereby helping to avoid Condorcet cycles and to make the public's collective views more 'rational' than they would otherwise be.)

Even if work of this kind rarely makes specific testable predictions, it often offers new and surprising perspectives on old questions. For example, one might explore how a politician, uninhibited by the need for logical consistency, should behave if trying to appeal to a population with cyclic preferences. If the opinions of the majority involve some contradictions and apparently irrational cycles of preference, then a candidate trying to match the public as closely as possible might well have to abandon consistency and use more flexible and slippery tactics to appeal to as many voters as possible.

Some researchers have suggested that this might be related to our perpetual difficulties in working out precisely where politicians stand (www.arxiv.org/abs/cond-mat/9806359). Just maybe, there's a certain logic to the politicians' apparent love of inconsistency and waffle. They're merely responding to our own collective confusion.

Mark Buchanan

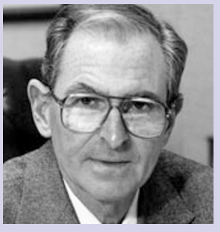
True or false

In 1989, the University of Utah announced what seemed to be the scientific discovery of the century: nuclear fusion, producing usable amounts of heat, could take place on a table-top, through the electrolysis of heavy water using electrodes made of palladium and platinum.

The cold fusion story seemed to stand science on its head — not only because it was played out in the popular press without the ritual of peer review, but also because both sides of the debate violated what are generally supposed to be the central canons of scientific logic.

Science in the twentieth century has been much influenced by the ideas of the Austrian philosopher Karl Popper. Popper argued that a scientific idea can never be proved true, because no matter how many observations seem to agree with it, it may still be wrong. On the other hand, a single contrary experiment can prove a theory false forever. Science advances only through demonstrating that theories are false, so that they may be replaced by better ones.

The proponents of cold fusion took the opposite view. Many experiments, including their own, failed to yield the expected results. These were irrelevant, they argued, incompetently done or lacking some crucial ingredient. Instead, all positive results — the appearance of excess heat or a few neutrons — proved the phenomenon was real. This anti-popperian approach played no small role in cold



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fusion's downfall, as seasoned experimentalists refused to believe what they couldn't reproduce in their own laboratories: to them, negative results still mattered.

On the other hand, the anti-cold-fusion crowd was equally guilty, if you believe another of the solemn canons: that science must be firmly rooted in experiment or observation, unladen with theoretical preconceptions. On the contrary, the failure of cold fusion was due, above all, to the fact that it was an experiment whose result was contrary to prevailing theory.

In spite of the well-founded scepticism of most scientists, there are still a few serious people around who believe in cold fusion. Let's all hope they're on to something.

David Goodstein