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January 2001

Regulars

## Opinion



### Topics of the month

- [Hanging on a chad](#) – voting systems and presidential elections
  - [One-two-three cheers](#) – wear your maths on your sleeve
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Have you anything to say on these or other subjects of interest to *Plus* readers? E-mail [plus@maths.cam.ac.uk](mailto:plus@maths.cam.ac.uk).

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### Counting the votes

The US presidential election turned into high drama when results in the critical state of Florida were initially too close to call. Recounts started, stopped and started again amid a flurry of lawsuits. Eventually the Supreme Court disallowed the recounts, handing victory in Florida, and hence the presidency, to Republican candidate George Bush. Interestingly, Bush received fewer votes nationwide than his closest rival, Al Gore, the Democratic candidate. The Electoral College system, by which votes are aggregated by state, happened to work in Bush's favour.

Where is the relevance of mathematics to these shenanigans? A notorious mathematical result proves that any voting system whatever, where voters choose between a number of alternatives, suffers from an unpleasant and paradoxical-seeming feature. It is known as Arrow's Theorem after its discoverer, Kenneth Arrow.

Suppose that all voters rank the candidates in an order of preference, and that using these preferences, we want a ranking of the candidates that somehow expresses the voters' democratic verdict. We might hope for the following: that the final ranking of two candidates, A and B, depends only on the voters' individual rankings of A and B. Whether and how much some voters prefer, say, A to C, will not affect the final ranking of A and B. Let's call a voting system where this is true "supernice". Arrow's Theorem states that, on very modest assumptions about the voting system (for example, that voters may rank candidates in any order), superniceness is impossible!

One common system gives victory to whoever has most first-preference votes. This can hardly be expected to be supernice, since it does not even ask how voters ranked the candidates other than their first choice. Indeed,

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it can easily give first place to a candidate who is the bottom choice of, say, 60% of the voters. If the first preferences of those 60% are evenly split between two other candidates (A and C), their least favourite candidate B might win the election 40–30–30. Voters' preferences between A and C have affected the final result's preference between A and B. More complicated systems of voting, where votes are transferred or different weights attached to different preferences, may come to a different conclusion in this case, but they cannot escape the unerring aim of Arrow's Theorem.

During the Florida recounts, various odd features of the election came to light, which, had the result not been so close, might have remained buried. One was the voting paper used in Palm Beach county, whose poor design seems to have led a number of people to vote for the wrong candidate by mistake. Some voters apparently had to indicate their choice by punching a card by machine, using machines over 50 years old which sometimes failed to punch the card successfully! In machine counts, these faulty cards were not counted for any candidate. (Hand recounts would have rectified this in most cases, but the recounts were deemed unconstitutional by the Supreme Court.) As polling stations in affluent areas had usually discarded these unreliable old machines in favour of more modern technology, a disproportionate number of discarded votes were in poorer areas. And in some areas claims were made of deliberate disenfranchisement of black voters by wrongly including their names on a list of people who, by virtue of criminal convictions, were disqualified from voting.

The presidential election, like any election, was subject to Arrow's Theorem. Indeed, the way in which Green Party candidate Ralph Nader took votes which would probably otherwise have gone to Gore is similar to the three-way election we imagined earlier. On another level, the fact that Gore took more votes nationally than Bush, yet lost the election, is another example.

But these are, at worst, inevitable anomalies of a system set up with a certain logic to it. Mathematical analysis might suggest a different system, but Arrow's Theorem ensures that some anomalies would remain. Besides, the system was well understood when the country went to the polls: people knew how their votes would be counted, and were prepared to accept the result.

On the other hand, in voting, as in any real-world situation, mathematics can only take you so far. The kinds of irregularities by which thousands of votes are not counted at all, or by which poor and black voters are systematically discriminated against, are not an inevitable mathematical consequence of any theorem. It is the fact that these votes were never counted that makes the election's claims to be democratic look dubious.

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## 1,2,3,4 – Step onto the dance floor



**Sanju Pal** takes up the challenge of replying to [Dominic Smith's comments in Issue 12](#) about the social image of mathematicians. *This needn't be the last word – what do you think?*

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Reflecting on my own past meetings with members of the opposite sex (or indeed members of my own sex), I can honestly say that I have never tried to worm my way out of mentioning which A-levels I do. I do get horrified reactions when people hear that I do four academic subjects (I just say I cope by not doing the necessary work!). But I've never had to deal with the tasty morsel I'm talking to running away because he's just realised that I am actually a character from Star Trek ...

Perhaps I expected some stigma and was pleasantly surprised, but in any case it seems to me that more and more people have begun to accept that there are some of us out there who actually like science. When it comes to A-levels there are two main paths to choose from, and people are aware that science is one of them. "Rather you than me" is a phrase I've heard used, but surely that is more to do with the fact that we each have our own interests. I know I've reacted similarly to students who tell me they've taken English literature, History and Politics. All of us who have chosen to go further with our education are in the same position, continuing to study the subjects we enjoyed from GCSE. No type is really socially more accepted than the other, especially not when you're out with your friends having fun.

Taking science doesn't affect how you behave in social situations, it is a part of your personality but it does not determine your personality. Those of us who like having fun, and are loud and proud with a lot to say and are not ashamed to say it can still be mathematicians! Anyone who chooses not to associate with an attractive, intelligent and interesting person just because they take maths simply has a few screws loose. If I met someone like that *I'd* be repulsed and have to run away to look for my friends.

I think that the key is to not lie; not to see taking maths and physics as information that should be kept as a deep dark secret, never to be revealed even under torture; not to worry that a situation might present itself where, oh dear Lord, you may have to mention the word "maths" in association with your very good name. Why should we seriously care? Why should I feel insecure when the truth of the matter is that I am good at maths because I enjoy the intricacies of the subject and its logical nature?

Surely the old stereotypes will disappear, but not if young scientists are afraid to mention that they study the sciences lest they may be deemed sad. Sensible young adults do not seriously think that those of us who take maths and science are "geeks". That classification is based on being a keen worker. There has always been an opinion that science is difficult and can therefore only be studied by people who must sit in front of textbooks all day long in order to do well (possibly repeatedly reading through "Mastering Mechanics" because it is the only one with pictures). But as you work towards higher education you meet an ever-rising number of people, even, umm, "artists", who have to work hard to do well. All these people have something in common: a desire to work hard in order to achieve their best.

I don't think the dance floor is the battleground of scientists and artists. It is our common ground, where like-minded young adults have come to have the fun everyone wants – even us mathematicians.

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## About the authors

Dr. Robert Hunt is the Editor of Plus Magazine.

*Sanju Pal* is in her final year studying A Level Mathematics, Chemistry, Physics and Latin at Camden School for Girls. If you meet her at a party she will happily tell you she wants to be a computer scientist!

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