Ed Walsh

Key words

patterns

medical trial

double blind

publication

Bad Science

Patterns, trends and dastardly traps

One of the things that we do as scientists is to look for patterns in data. **Ed Walsh** *explains how this can go wrong.*

Patterns are useful because, if we do a number of tests and the results fall into a pattern, it probably means we're doing something right. Then we can look for an explanation of the pattern. For example, you've probably seen alkali metals reacting with water. Alkali metals are in Group 1 of the Periodic Table and are in a column over at the left hand side. The first three are lithium, sodium and potassium. They all react with water and are increasingly reactive as you go down the group. The next one down, rubidium, isn't allowed in schools and the one after that, caesium, is even more dramatically explosive.

You can see why by searching for ***caesium reaction*** on YouTube and watching the Open University clip. It takes you through all five in three minutes and you can see a simple pattern. (Don't trust the Brainiac clip –they added explosives to spice things up!)

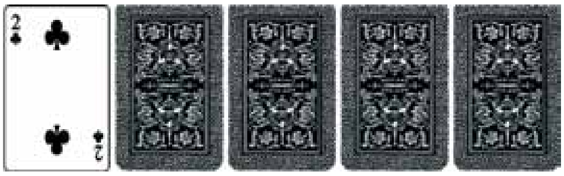
Misleading patterns

Patterns can be dangerous though. Sometimes we can convince ourselves that we're getting a pattern. Imagine you were doing a simple test, tossing a coin and writing down the results. (It's an unbiased coin, with an equal chance of coming up heads H or tails T.) You do eight flips and then try to work out the ninth. What would you guess as being the ninth flip from each of these?

a) H T H T H T H T?
b) H H T T H H T T?
c) H H H H T T T T?

The answer is, of course, you've no way of knowing. Any of these, on the ninth flip, could just as easily be heads as tails. Patterns can be misleading.

So how do we tell if there's really a pattern, or whether it's just chance? And does it matter? Well, yes, it does matter. It can be a matter of life and death. We'll see why in a minute, but let's play some cards first. This is a very simple (and, I mean, *very* simple) game. It's called "Play your cards right" and used to be a TV programme, featuring Bruce Forsyth (now on Strictly Come Dancing). In the programme Bruce would present a contestant with a row of cards, face down. He would then turn the first one over. Let's say it was a two. The contestant would then be asked whether the next card was going to be higher or lower (Ace = 1, Jack, Queen, King = 11, 12, 13) and the audience would call out "higher" or "lower".

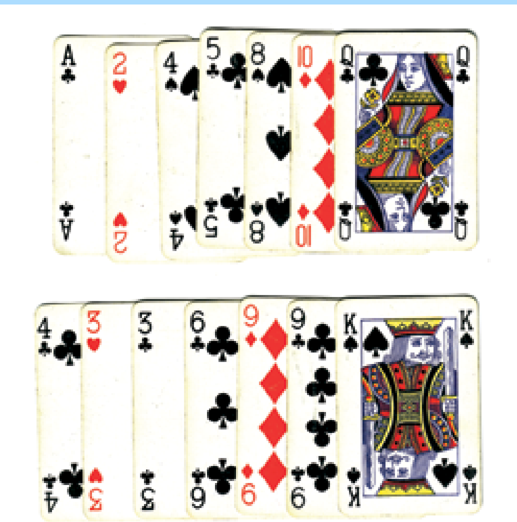


Of course, if your last card was lower than seven, you'd predict "higher"; if it was higher than seven you'd predict "lower". This neatly demonstrates a principle called "Regression to the Mean". You don't know what the next card will be but you do know the values rise and fall around a mean (in this case, of seven). A contestant would be ill-advised, following a sequence of five, seven, nine, Jack to call "higher" even though there might seem to be a pattern of the value increasing by two every time.

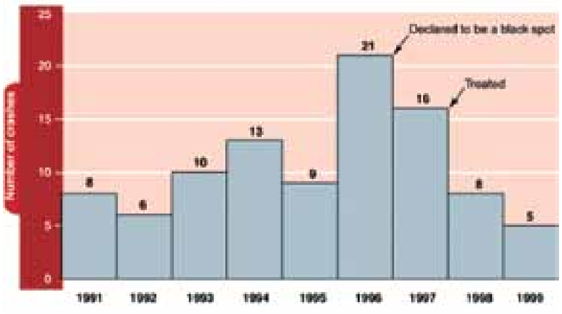
Spot the pattern

Scientists are pattern-spotters, but the underlying patterns in nature are often difficult to see. Can you spot the patterns in the sequences of cards below? Each sequence runs from left to right.

The problem is to decide which features are relevant and which are irrelevant. For cards, this could be their numbers, suits or colours – or a combination of these. The answers are at the end of the article.



Statistical black spot



Annual road crashes on the Tullamarine Freeway, Victoria, Australia. Source: Victorian Government

Let's apply this, however, to fatalities on a road. The graph shows the annual figures for crashes on a freeway in the Australian state of Victoria. Starting in 1991, they go: 8, 6, 10, 13, 9. Not good, but it's a long, busy, fast road. It then jumps the following year to 21. The authorities, stung into action, declare it to be an 'Accident Black Spot' and the figures drop to 16 the next year. The following year warning signs, road markings and a speed camera are installed. The next year the figure is 8 and the following year 5. Everyone breathes a sigh of relief: the preventative measures have worked – or have they? Well, applying the principle of 'Regression to the Mean' it's not obvious that they have. Road accidents are random events and will rise and fall year by year – who's to say they wouldn't have dropped anyway?

Medical testing

When you receive medication, you expect it to have been tested correctly against other possible treatments.

This also applies when it comes to testing medicines and other treatments. Surely, if you come up with something that you think will work, you give it to someone who's ill and see if they get better? Do that a few times, publish the results and collect your winnings from big pharmaceutical company. Actually, no. People get better for lots of reasons. Imagine someone told you that a guaranteed cure for a cold is to treble your chocolate intake and after a few days you won't have a cold. You try it and, after a few days, your cold has gone. You remain, however, sceptical, and rightly so.

Bad Science – the author, the book and the website.

Bad science, better science

Ben Goldacre is a doctor and a journalist. He's written a book called Bad Science, he writes a newspaper column called Bad Science and runs a website called ... you've guessed. He's really hot on why, when you're testing a new medicine, you have to get it right. If you don't, then people die. So if you have a new drug that you're itching to try out and prove, what do you do?

Well, three things, so that you end up with a randomised controlled double-blind trial:

- Firstly you compare it against another treatment. The big question is not whether your drug works but if it works better than the current treatment, so run a comparison. Head to head.
- Secondly, you set up two groups of patients to try the drugs on (one for the new treatment and a **control group** for the current treatment) but the patients in each group are selected at **random**. Randomisation doesn't cost anything but it's essential.
- Thirdly, you don't tell people which treatment they are getting. In fact, you don't tell the people who are *administering* the treatments which they are using. This is called **double blinding**.

Actually there's a fourth thing. You publish the results. All of them. Scientific understanding doesn't just develop from little bits of information discovered like bits of a jigsaw that have dropped on the floor and have been found, but from arguments. Real, stand-up-and-shout arguments. Sea floor spreading, evolution and the periodic table all came from arguments. Arguments over what the evidence shows.

Science – use and abuse

Bad Science is about how science is used – and abused. Many of these abuses are not difficult to detect if you're given a few pointers. That's what Ben's book is about. Some of these ideas have been turned into classroom activities; they're on the web at www.collinsnewgcsescience.co.uk/badscience along with video clips of pupils trying the ideas out and Ben Goldacre talking about why these are important.

Ed Walsh is a science adviser in schools in Cornwall

Solutions *to card sequences on page 17:*
Sequence 1 – numbers increase from left to right;
Sequence 2 – even numbers are followed by red, odd numbers are followed by black.