

# Uses and Abuses of Probability

Hugh Mellor



In 1963 I anticipated later changes in the UK economy by leaving manufacturing for a service industry: in my case, by leaving chemical engineering at ICI to do a PhD on the philosophy of probability at Cambridge. I then discovered that this subject is a very good example of the intellectual service which Cambridge philosophy renders to many disciplines. Cambridge is a great place not only for the mathematical theory of probability and its scientific applications, but also for its philosophical foundations. From John Venn in the nineteenth century, through Maynard Keynes, Frank Ramsey and Richard Braithwaite in the twentieth, to expatriates like Ian Hacking and Donald Gillies now, nowhere has contributed more than Cambridge to our understanding of it.

Take Venn, the first great advocate of a frequency view of the chances – objective probabilities – postulated by physicists, geneticists, meteorologists, insurance companies and casinos: the view that a smoker's chance of getting cancer, for example, is just the fraction of smokers who *do* get cancer. Keynes, by contrast, originated a logical view of the so-called epistemic probabilities used to measure how far evidence supports conclusions drawn from it, such as the verdicts of law courts, the

results of clinical trials and the acceptance or rejection of scientific theories. And Ramsey was the first to make a subjective view of probability credible by showing how our decisions are affected by – and can be used to measure – the probabilities we attach to their possible consequences: as when people decide to stop smoking because they think they are less likely to get cancer if they stop than if they don't.

On the face of it, these three applications of probability are quite distinct. The chances of rain tomorrow, of offspring being male, of catching flu, or of winning a lottery, are features of the natural or social world that do not depend on what we know or think about them. Not so the

epistemic probabilities of a defendant's guilt, the safety of a new drug or the theory of evolution by natural selection: they only measure how far our evidence counts for or against these hypotheses. While subjective probabilities measure neither of the above, merely the actual strengths of our beliefs, which are what determine how we act when we are uncertain – as we often are – of what effects our actions will have.

Yet distinct though these three kinds of probability are, they are not wholly independent. They are not, for example, like light, sound and water waves, none of which implies anything about the other two, despite all being waves, i.e. all obeying similar mathematical equations. Our three kinds of probability, by contrast, are linked by more than a shared mathematics. Smokers' chances of getting cancer also tell us how far the evidence that they smoke supports the prediction that they *will* get cancer, and therefore how probable we and they should take that prospect to be. The greatest challenge for philosophical theories of probability is in fact to explain not just these three applications of it but why they are linked as they are. That remains an unsettled question, with rival theories still vying

for acceptance by practitioners and philosophers alike.

These controversies do not, however, prevent the exposure of many mistakes in the application of probability, some of considerable practical or theoretical importance. Most people know that the so-called 'gambler's fallacy' – the idea that, for example, landing heads ten times in a row makes a normal coin less likely to land heads next time – is just that: a fallacy. (If that sequence of heads tells us anything, it tells us that the coin is *more* likely to land heads than we thought.)

Other errors can be less easy to spot. Take the extreme probabilities invoked when a defendant in, say, a rape case is identified by DNA evidence. Suppose for simplicity that the probability of a false match – i.e. of DNA samples from two different people matching – is one in ten million, and that a sample from the scene of the crime matches the defendant's DNA. It may be tempting, given the enormous odds against a false match, to think that this evidence alone proves the defendant's guilt. But it does not. For suppose the only other evidence about the rapist is that he is an adult male in the UK, which contains well over ten million such males. Then all the DNA evidence tells us is that the rapist is likely to be one of at least two people, of whom the defendant is one. So on this evidence the epistemic probability that the defendant *is* the rapist, far from being over 99.99%, is less than  $\frac{1}{2}$ , which is too low to prove his guilt even on the 'balance of probabilities' needed to win a civil case, let alone 'beyond reasonable doubt', as required for a criminal conviction.

Errors with fewer practical implications but perhaps more theoretical interest are made by some cosmologists and theologians who are over-impressed by the apparent improbability of those features of our universe needed to produce more or less intelligent life. This so-called 'fine-tuning' of our universe's laws, constants and initial conditions has seemed to many to call for some natural or supernatural explanation. The latter may be that our universe was *made* to support intelligent life; the former that we live in a 'multiverse' containing many universes, with many different features, which makes it not only probable but inevitable that

intelligent life will arise only in the few universes that can support it.

Where is the error in this? Not in the platitudinous conclusion that life can only arise in a universe that can support it. The error lies in assuming that such a universe is improbable in any sense that makes its existence call for explanation, an error rooted in a failure to distinguish chances from epistemic probabilities. Of course our evidence gives the relevant features of our universe a high *epistemic* probability, since all this means is that it tells us what those features are. It does not follow from this that there is any such thing as the *chance* of a universe having these features, let alone that only something like a design or multiverse theory can make that chance high enough to make our existence unsurprising. Nor does this follow from the fact that our universe could have been different in many ways, most of which would not have allowed it to support life. The most that follows from this is that the epistemic

probability of our kind of universe, relative to no evidence at all, would have been very low, which again is just to say that it's only the evidence – including the evidence of our own existence – which tells us what our universe is like.

None of this shows that design or multiverse theories are false, merely that some bad but common reasons for thinking or wanting them to be true are based on too indiscriminating a view of probability. A more discriminating view helps us to adopt the attitude expressed in Thomas Carlyle's alleged comment on one Margaret Fuller's reported remark that she accepted the universe: 'Gad,' said Carlyle, 'she had better.' And so, I think, had we.

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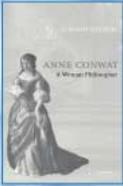
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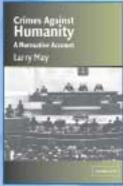
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