PROBABILITY: A PHILOSOPHICAL INTRODUCTION

D. H. MELLOR (Routledge, 2005)

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This is a wonderful book, and a very good example of analytical philosophy of science at its best. It has been marketed as a textbook, and it serves the purpose admirably, particularly for postgraduate and advanced undergraduate courses in both science and philosophy of science. But its ambition goes well beyond a mere textbook. Over ten chapters a particular view in the philosophy of probability gradually develops in painstaking detail. And it turns out to be a remarkably subtle, rich and nuanced view. As the reader progresses through the book the different parts begin to fit as in a puzzle. For the book is extraordinarily didactic, as well as superbly well edited and cross-referenced throughout. Mellor's view is finely crafted, and his writing displays the deep-seated learning and experience of a scholar who knows his way around the topic. As it happens one of the few comparable recent achievements is another book on probability, namely Donald Gillies' more historically oriented *Philosophical Theories of Probability* (also published by Routledge a few years beforehand). Together these books set a very high standard in the philosophy of probability that is unlikely to be surpassed in some time.

The first chapter sets up the main terms and concepts for the rest of the book. The presentation already displays unusual depth, since it divides probability into three kinds as opposed to the usual two – subjective estimation of likelihood or *credence*, and objective physical *chance*. Mellor adds a third kind – *epistemic* probability – in connection with the confirmation of scientific hypotheses by evidence. After briefly introducing each of these notions, the first chapter concludes with a discussion of the formal features of numerical probability, i.e. the concept of conditional probability and the Kolmogorov axioms. It is thereafter assumed that all three kinds of probability must conform to the axioms. In addition Mellor demands that each kind of probability be "interpreted", and he imposes the following demand upon these interpretations: either they are identical in all three cases or - if they differ - "those interpretations must between them explain why probabilities of these different kinds are linked as they are" (p. 21). This is the demand that drives the entire book and gives rise to Mellor's own views. (It strikes me that this is a presupposition of Mellor's views that may be questioned, particularly since - once it is granted - most of Mellor's conclusions seem to me to inexorably follow. It is certainly not universally accepted that all different kinds of probability require interpretation.)

Thus the next four chapters discuss the classical, frequency, propensity and subjective interpretations of probability respectively. Chapter 2 introduces the classical or logical interpretation of the probability calculus according to which probability measures degree of possibility. It consequently ascribes probabilities on the basis of Laplace's principle of indifference (PI), a version of the contraposition of Leibniz's principle of sufficient reason. PI is explained with the aid of the framework of sample and outcome spaces, which may be summarised roughly as follows. A sample space is a collection of sample points, each representing some possible simple outcome of an experimental trial; an outcome space is the collection of the subsets of sample space that are possible complex or simple outcomes of that trial. In the absence of further information PI ascribes equal probability to equipossible simple outcomes, while the probability of

more complex outcomes is a function of the probabilities ascribed to the simple outcomes that make them up. Mellor then explains how the classical interpretation is inadequate for both chances and epistemic probabilities: The application of PI to uniform density distributions generates inconsistent ascriptions of probability values to identical events relative to different but equally valid partitions of the sample and outcome spaces. Chapter 3 takes up the frequency interpretation, according to which probabilities are relative ratios of outcomes in actual finite sequences ("finite frequentism"), their limits ("limiting frequentism"), or hypothetical infinite sequences ("hypothetical frequentism"). Mellor shows that none of the varieties of frequentism is appropriate for either credences or epistemic probabilities. Frequencies are rather consonant with a Humean understanding of chance. (A Humean thinks that there are no metaphysical modalities; so chances can not be properties instantiated in possible worlds, and must be reduced to regularities in the actual world). The usual objections to frequentism are reviewed: Finite frequencies can not deal with the single case, limit frequencies suffer from the well-known reference class problem, while hypothetical frequencies are hard to square with the Humeanism that motivates frequentism in the first place. Suppose that the chance ½ of a coin to fall heads is understood as hypothetical frequency. What physical feature or property determines this value? The Humean has no answer to this question: It can not be any actual frequency in a finite sequence, for the ½ ascription is consistent with any such frequency whatsoever. Mellor thinks, and I agree, that propensities are required to fix the values of hypothetical frequencies.

Chapter 4 consequently introduces the propensity interpretation. Mellor first considers a version of the classical interpretation, i.e. "modal chances". These are metaphysical possibilities that entail hypothetical limiting frequencies. Modal chances are as implausible as hypothetical limiting frequencies, but come at an impossibly high metaphysical cost: In order to solve the reference class problem they require a notion of possibility within the actual world, which the standard possible world semantics can not accommodate. Mellor then turns to the alternative dispositional view, namely propensities. Propensities are dispositions to display probability distributions under appropriate test conditions. There is an issue here as to how to define propensities in relation to chances. Mellor is uncharacteristically unclear on this matter. The standard line taken in the philosophy of probability ever since Popper is that propensities *are* probabilities, and that the axioms of probability define propensities. (I like to call this the "identity thesis"). At some point Mellor wisely distinguishes his view from the identity thesis, but at other points he identifies propensities with chances, and then separates chances from frequencies. I find all this unnecessarily confusing. It seems simpler to stick clearly to three separate notions as follows: frequencies are ratios in outcome sequences (whether actual or virtual); chances are the objective probabilities that frequencies provide evidence for; and propensities are dispositional properties invoked to explain chances. A plethora of arguments – not all presented in the book – support the need for such partition. Despite the lack of clarity at this point (and the occasional disagreement that there is no room to explore in this short review), I found that this chapter was a thought-provoking gem.

Chapter 5 deals with credences, or degrees of belief (DoBs). After distinguishing DoBs clearly from both chances and epistemic probabilities, Mellor reviews the standard coherence (i.e. Dutch book) argument showing that coherent betting quotients must conform to the axioms of probability. Coupled with Ramsey's view that DoBs are

measured by – if not operationally defined by means of – betting quotients, this yields the thesis that DoBs too obey the axioms of probability. There has been a long debate about whether this is a descriptive thesis regarding all our DoBs, or a normative one regarding *rational* DoBs. (On the normative view, there can be *irrational* DoBs that do not conform to the axioms). There is plenty of empirical evidence that most people's beliefs fail to conform; hence most philosophers adopt the normative stance. Mellor unusually adopts the descriptive view, but adds a very important caveat, namely: betting quotients are models of our beliefs. Hence, like all other models, they idealise: They merely approximate our degrees of belief. So, strictly speaking, betting quotients are false descriptions of our DoBs.

Chapter 6 reviews confirmation theory and introduces two main principles. The Evidence-to-Credence (EC) principle (p. 79) connects epistemic probabilities and credences and states that "the more B confirms A, the greater the degree of belief in A which B justifies". The Chances-as-Evidence (CE) principle (p. 85) is really just a version of Lewis' principal principle connecting chances and degrees of belief, and it stipulates that the epistemic probability of an event A must dovetail with the objective chance of the event: EP (A / CH (A) = p) = p. Mellor then shows that the best account of confirmation relations is by means of the EC principle. Chapter 7 explains the notion of conditionalisation central to Bayesianism – the mechanism that describes the temporal updating of credences. Mellor shows that conditionalisation can be justified by the pro rata rule, if the evidence is certain, and then goes on to emphasise the problem with prior credences. The justification of any credence obtained by conditionalisation depends on the justification of the prior credence that is fed in to start with. So unless we find a way to justify the latter, the attempt to turn Bayesianism into a theory of confirmation relations via (CE) will falter. Chapter 8 consequently deals with epistemic issues in the justification of priors and proposes three alternatives: foundationalism (in basic perceptions), coherentism (of all our beliefs), and reliability (with regards to truth). The first two approaches exhibit major defects, while the latter requires us to postulate chances, contrary to Bayesian intuitions. Chapter 9 then rehearses well known arguments for and against conditionalisation, including Lewis' influential dynamical betting quotient argument, and raises an unusual objection to it. In the last chapter of the book Mellor rehearses a number of principles that serve to connect chances and credences, interpreted as propensities and Bayesian degrees of belief respectively, in ways that may justify using credences as a measure of confirmation. Thus the promise of the book to eventually connect all notions in productive ways is finally carried through successfully.

One of the most striking aspects of the book is the introduction of a tripartite distinction where normally only a dichotomy is presented. I was initially dubious about the introduction of a third kind of 'epistemic' probability. This is a non-standard move since confirmation is usually subsumed under subjective probability - as indeed Mellor himself acknowledges it must be in chapters 6 and 7. A tripartite distintion seems historically unwarranted too. Subjective estimates of likelihood and objective chances alike originate in the 17th century, and the dichotomy between subjective estimation of likelihood and objective physical chance was canonical in the literature even before Carnap consigned it in his "probability$_1$" and "probability$_2$" labels. So what is the point of introducing a third notion?

I was eventually won over by the tripartite distinction, and came to regard it as one of the book's main achievements. Let me briefly explain why. The book may be understood as a treatise on Bayesianism – certainly more space is devoted to this view than any other. However, the book is unusual in coming out on balance *against* the Bayesian programme, at least its universalistic aspirations; and the introduction of epistemic probability is an excellent way to convey what Mellor thinks is questionable about it. Bayesians cannot account fully for *any* kind of probability in their own terms. They cannot account for propensities at all, nor even countenance their existence, which makes it extremely hard to countenance chances. But without chances they cannot account for credences either because of the well known failings of conditionalisation to provide the required justification for our beliefs. What is perhaps less well known is that independently of these failures, Bayesians cannot account for confirmatory relations - unless they are prepared to let in chances as well. The objection comes to the fore in the excellent final chapter but it really runs through the whole of the second part of the book. Such a major objection to Bayesianism is certainly something I had not realised in full force before I read Mellor's book, and it can only be appreciated under a tripartite distinction between chances, credences, and epistemic probabilities.