

# Preface

Science aims at the discovery of general principles of special kinds that are applicable for the explanation and prediction of the phenomena of the world in the form of theories and laws. When the phenomena themselves happen to be general, the principles involved assume the form of theories; and when they are particular, they assume the form of general laws. Theories themselves are sets of laws and definitions that apply to a common domain, which makes laws indispensable to science. Understanding science thus depends upon understanding the nature of theories and laws, the logical structure of explanations and predictions based upon them, and the principles of inference and decision that apply to theories and laws. Laws and theories can differ in their form as well as in their content. The laws of quantum mechanics are indeterministic (or probabilistic), for example, while those of classical mechanics are deterministic (or universal) instead. The history of science reflects an increasing role for probabilities as properties of the world but also as measures of evidential support and as degrees of subjective belief. Our purpose is to clarify and illuminate the place of probability in science.

The fundamental conceptions of probability that matter to science are both objective as properties of the world: *the frequency conception*, for which “probabilities” stand for relative (or limiting frequencies) of outcomes (such as heads) across sequences of trials (such as tosses of coins); and *the propensity conception*, for which “probabilities” stand for the strength of the causal tendencies for specific trials (or sequences of trials) to bring about specific outcomes. The frequency conception is a collective concept that applies to sequences of trials collectively (as a group). There is no relative frequency (or only a derivative value) for an outcome to occur on a single trial, although they are sometimes described that way. By comparison, the propensity conception is a distributive concept that applies to trials distributively (one by one). There are causal propensities for outcomes to occur on single trials, where different members of a sequence of trials can have causal propensities that vary from one trial to another when they occur under different conditions.

Evolutionary theory and quantum mechanics are among the most important scientific contexts in which objective probabilities play a role. The notions of biological fitness and of radioactive half-life, for example, both appear to be probabilistic properties. This volume includes several chapters devoted to their clarification. And

it is quite important to distinguish between subjective conceptions of probabilities as properties as *beliefs about probabilities* (say, believing that the probability of heads on the next toss with a coin equals  $1/2$ ) and as *degrees of belief* (say, having a degree of belief equal to  $1/2$  that the next toss will be heads). Beliefs about probabilities are true when the world has those properties; degrees of belief are true when people do. These properties are closely related, since it is widely assumed that beliefs about probabilities determine degrees of belief. David Lewis even calls this relationship “the Principal Principle”. It sounds simple, but understanding how it works is complex.

We begin with a comprehensive introduction to alternative conceptions of objective probability and the difficulties that they confront. The first section then follows with three studies of special problems that arise within this context and the comparative merits of different accounts. The second section addresses the nature of lawfulness and of relations between micro- and macro-probabilities, especially with reference to the concept of fitness in evolution. The third section confronts some of the difficulties confronted by causal conceptions of probability, especially within the quantum domain. The fourth extends the discussion to principles of inference and decision. The last chapter relates propensities and frequencies to the framework of inference to the best explanation. It all begins with an introduction that integrates these contributions and their interconnections, and it ends with an expression of our gratitude to the distinguished contributors who have made this collection possible.

When I retired from the University of Minnesota Duluth in June 2006 after 35 years of college teaching and moved to Madison, my wife, Jan, and I were looking forward to spending time with Ellery and his wife, Joanne, with whom we had spent many enjoyable evenings together over the years. We met in 1980 while I was visiting The University of North Carolina at Chapel Hill and Ellery was teaching at North Carolina State. We had only just moved into our new home in Oregon, WI, when we learned that Ellery had been hospitalized. Jan and I were able to visit him at Meriter Hospital shortly before he died on August 10. It was an acute loss for me and for the fields of philosophy to which he so richly contributed. Fortunately, we had completed our work on this project, including the Introduction of which he was the principal author. I have done my best to preserve his words throughout and offer this work as a monument to the excellence of his intellect as well as of his life as a husband, father, teacher and scholar.

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