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Hacking (1975) reports how historians had managed to write what was known about pre-Seventeenth Century probability in a little over half a dozen pages. James Franklin’s Science of Conjecture extends this to over three hundred pages with a history of how from the earliest recorded times thinkers have reasoned about events with uncertain outcomes and ambiguous data.

In the modern world works of history can tend to concentrate on the tedious detail of romantic lives and the construction of moral judgments about their subjects, so it is refreshing to see Franklin’s rather unfashionable approach, where historical texts which deal with uncertainty have been abstracted and put into context independently of any discussion or conclusions drawn from them. In this volume most higher level discussion is left to the end.

The structure of the book is one in which each chapter corresponds to one, or more, application areas, with a roughly chronological ordering within each chapter. This arrangement makes a great deal of sense, although it can be a little disorienting as some historical figures, such as Aristotle, feature in virtually every chapter.

In a work of this nature it is inevitable due to availability of the historical sources that the main focus of attention is Western European thought. There are places where Jewish, Oriental and Islamic scholars are cited and discussed, but unfortunately these are few and far between.

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Of most direct interest to *Law, Probability & Risk* readers are Franklin’s first three chapters on Ancient, Medieval and Renaissance Law. It comes as little wonder that very few examples of the use of evidence come from the Mesopotamian civilizations, however there is also little from Egyptian sources, which given the abundance of other written information about ancient Egypt is surprising. What there is seems to have two strands, one of which relates to the number of reliable witnesses willing to testify for, or against a case; evidence which remains important today. The other being the use of oracles and is not in use today. Even in the ancient world there seems to have been a laudable skepticism about the information divulged by oracles, sometimes two or three being consulted. It does not seem to have been recorded what to do if the oracles disagreed. Chronologically later than Mesopotamia and Egypt the Jewish tradition is notable in that it does not admit confession, a wholly worthy feature making torture useless. It also required a very high standard of proof which differed according to whether the case was capital or not.

Franklin then traces an outline history of Roman law, from early times with Justinian’s codification, to its continuance in the early Renaissance and the Glossator’s interpretation and explication of the Roman legal codes. The Roman law had the concept of onus of proof, but the wealthier sections of Roman society were considered more competent to testify than others. The Roman judiciary were allowed some latitude to judge in accordance with the evidence. In contrast to Jewish law, torture was widespread in Roman practice. In fact in some circles the evidence from a tortured witness was considered of a higher quality than had the same witness volunteered the evidence, particularly if they happened to be a member of the slave classes.

European Medieval law looked to the Roman codes, but started to take a more abstract view of law based on general principles. This included developments in the theory of evidence such as half, quarter, and finer grades of proof, and multiple supporting strands forming what we today would call a case. There seem to have been variable attitudes to the use of torture. Ordeal was used in the earlier period to support the civil law in cases which were otherwise intractable. An important tool for evidence evaluation with its beginnings in the Western European Medieval was the development of a form of jury
which has continued uninterrupted until the present day.

The mainstays of legal evidence throughout most of Western history seem to be oracles, witnesses, confessions and occasionally ordeals. Other elements were also considered important such as whether the elements of evidence in any particular case were reasonable *a priori*, that is, the alleged actions and events cannot be contrary to everyday experience and notions of reason. Indications such as the reputation and past criminal record of the accused could also be taken into account dependent on period and jurisdiction.

Franklin argues that there has been little change in the processes of reasoning into the modern period, and on the whole it is easy to agree with this view. Those bits which have changed are that in most jurisdictions torture is considered to produce unreliable and unacceptable confessions, and the effect of social standing of any witness is not supposed to make any difference to the value of that evidence. It can be argued that forensic evidence plays a much larger role in evidence in the modern era, but in some contexts has been viewed less critically than the oracles of the ancient world, and has led to embarrassing and costly miscarriages of justice. Having said that forensic evidence is a mainly modern source of evidence the ancient legal texts are peppered with references to suspects’ possession of ‘bloody swords’, documents, and articles belonging to the suspect being found at the crime-scene; so lawyers in the past were not wholly unaware that everyday objects could in themselves be thought of as evidence.

Chapter four deals with how people in the past addressed moral and ethical uncertainties. The whole notion of systematic thought applied to these matters seems alien these days where many people in the West take their notions of right and wrong, and how to act, from films depicting steely eyed mavericks ‘doing the right thing’. However, our ancestors developed a highly sophisticated framework for the exercise of ethics. Franklin starts with Aristotle’s Nicomachean Ethics, although the Ancient world had little else to offer in way of literature on moral and ethical uncertainty. Ethical debate in the West became firmly established with the consolidation of Catholic Europe. Much of the philosophical argument was about optimum courses of action which would minimise sin. Such problems as whether a priest should celebrate mass or not are difficult where it
is uncertain to the priest whether he is corruptly appointed or not. Not taking mass if legitimately appointed would be a sin, taking mass if corruptly appointed would also be a sin. One early school of thought, called the rigorist or tutiorist approach would require a standard of proof which made it more probable that the priest were legitimately appointed than not before the priest could take mass. A more liberal approach which came about in the late sixteenth century was called probabilism, which would have our hapless priest take mass were he reasonably sure he was legitimately appointed, despite evidence for a corrupt appointment. Later in the sixteenth century Laxists would hold that the priest would only have to have some idea that he were legitimately appointed, even if the evidence pointed mostly to a corrupt appointment. On the face of it the schools of thought seem well defined, but there is little which actually relates evidence in any operational fashion to support for propositions.

After reading Franklin’s chapters on law, and chapter on ethics, it is surprising how little interplay there seems to have been between the two fields, despite developments in one being in the same place, and same time as the other. For example; the schools of ethics which came about during the sixteenth century do not seem to have parallels in legal thinking. A possible reason in Northern Europe could be the interposition of the Reformation, and rejection, or isolation from, Catholic epistemological developments, but it is difficult to apply this reasoning to the whole of Europe.

Logic and rhetoric are then examined. Rhetoric is treated a a form of reasoning about uncertainty because of the Sophists use of plausible argument in Classical Greek law. The chapter continues with the logic of uncertainty addressing evidence combination in the Roman courts, Scholastic methods for non-deductive reasoning, and later seventeenth century logics.

Chapter six traces the use of probabilistic ideas in the hard sciences, mostly astronomy. The problem which needed solving seems to have been a plethora of observations from heavenly bodies which did not agree with each other despite being from the same astronomical entities. The idea of using a combination of these data to get some harmonious value which could be explicitly modeled is a thread of recognizably modern treatment of
uncertainty which was pursued from the time of Hipparchus in the second century BC through the work of Copernicus and Kepler and on into modern times.

Chapter seven features sciences for which precise measurement is not an overwhelming feature. This includes physiognomics (the science of inferring character from appearance) and astrology. Interestingly two of the great astronomers, Ptolemy and Kepler, were also astrologers, who defended their art by saying that astrology, like astronomy, could only predict tendencies and not specific events in the future. This is understandable as given the state of pre-Newtonian astronomy there could have been few reasons to reject astrology on strictly empirical grounds.

The section on medicine takes us through two broad, and not entirely distinct schools of induction termed dogmatists and empirics. Dogmatists tended to look for causal mechanisms to explain observable phenomena. Empirics denied that any knowledge of underlying process could be gained from observation, and would only admit knowledge of an effect based upon many instances. Despite this epistemological problem, medicine in pre-modern times must have had some pragmatic, and effective means of combining observations from disparate sources as some remedies known from ancient times do have definite therapeutic effects. Examples are the use of digitalis for dropsy, willow bark as an analgesic, and by the fifteenth century the widespread use of smallpox vaccination in the Arabic countries.

From a more practical stance Franklin discusses methods of frequency counting and sampling. The Jewish Talmud gives advice on how to act in day to day cases where it may be uncertain as to whether a specific article from a batch of ritually prepared clothing, or food, is correct according to the ritual, or not. Essentially the technique is that of close examination of a sample and extrapolation to the population of items. Also in this fascinating section are gems such as the sixteenth century German solution to standardise a unit of length called the *rood* which was to sum the lengths of the left feet of sixteen men as they emerged from church. The thirteenth century English mint was assayed by quite a thorough-going random sampling method with the understanding at some level that weights of a large number of coins would be accurate even through each
coin may vary quite considerably from its prescribed weight.

Philosophy has traditionally offered a rational means to certain knowledge. Within the philosophical framework uncertainty sits uneasily. Franklin addresses this divide by examining how philosophers have dealt with inferences about matters not open to deductive reasoning.

Progress was made in the thirteenth century by Aquinas and his reasoning as to how individual examples of a class can vary due to mixtures of causes. Franklin rightly emphasises Aquinas’ achievement in his approach to unifying contingency with determinate causes, and goes on to outline later retrograde developments by Ockham and Scotus in induction and how inductions which happen all the time (things such as all fire is hot) can be resolved with those which happen less frequently.

Later in the fourteenth century Nicolas of Autrecourt demonstrated that little could be known with certainty, and all that cannot be known with certainty can only be known with probability. Most of the rest of the development of induction through Bacon, Descartes, Hobbes and Hulme, is an extension of Nicolas’ work into modern formulations of science, with provisional knowledge of causal principles which rely upon metaphysical principles such as aesthetics and parsimony as a guide to truth.

If there is a disjuncture between the truths offered by philosophy and the existence of uncertainty, then for the same reasons there is an equal problem with religious truths. The truth of the monotheistic religions is that the universe has an ultimate designer and that implies there is little room for chance and uncertainty. Indeed, from eleventh century Islamic scholarship al-Ghazali pointed out that even natural causal processes cannot exist as everything is a result of the will of the Deity. Twelfth century Christian scholarship had no such difficulties. John of Salisbury argued that all knowledge of the world is probable knowledge, and that things considered demonstrated are absolute truths. Siger of Brabant went further in saying that the fact of physical arguments had been demonstrated, and it was any metaphysical propositions which could at best be said to be probable. However in the fourteenth century the Inquisition burned Cecco
d’Ascoli for a causal necessity-based heresy which suggested that Christ’s life could be predicted from his horoscope.

Chapter ten is on the history of judgments made in the mercantile sector. The earliest evidence of this sort of activity are records found from ancient Athens where loans were made to finance maritime expeditions and the sale of annuities would require some carefully balanced notion of risk. The maritime loan was made in return for a share of the profits from a shipment of goods, and would need some idea of the probability of the ship sinking before any profit from the venture could be realized. Place the proportion too high and the shipping merchant would not consider it worthwhile, too low and the source of the loan would not be interested. There is evidence from the mid-fourth century BC of the price of a shipping loan being dependent on the season in which the ship sailed to account for variation in the weather and likelihood of storms. The Roman Digest contains what is possibly a table of life expectancies to enable the cost of annuities to be calculated based on the purchaser’s life expectancy.

Islam eschewed all forms of betting and generation of wealth based on risk, going as far as to ban the advance sale of crops which were not ready for harvest. This is still a feature of Islam. Devout Muslims in the United Kingdom still have difficulty in buying property because mortgages are precluded. Many jurisdictions have, or have had, some form of rule against usury. Morally-based circumventions to the problem occur as early as the beginning of the thirteenth century with Peter the Chanter considering risk as being in effect a form of work, and that if an investor exposed themselves to loss then usury would be avoided.

When it comes to money it would appear that most cultures had a fair idea of the payoffs between great gain, and probability of loss. A fourteenth century Genoese contract is made in the form of a maritime loan, but is obviously a form of insurance as no money was payable by the loan maker unless the ship sank. Life insurance seems to have been available from the early fifteenth century, however the form of it was more that of a bet with merchants taking out ‘insurances’ on the lifespan of the Pope and Doge of Venice.
Franklin points out that it is unfortunate that the details of exactly how insurers and annuity granters reasoned whilst setting out their premiums and prices is, with a few exceptions, not recorded. In contrast much more was written in those same periods by scholars about whether such activities were usurious, and their moral and ethical implications of usury.

Chapter eleven is on dice and other stochastic systems. Early references to a qualitative understanding of multiples of independent events come from Aristotle and Cicero on games of chance. Later Medieval writings deal mainly with condemnation of dice for both gambling and fortune telling. An interesting example is from Rabelais’ Judge Bridlegoose who used dice to decide the outcome of cases brought before him. In this story Bridlegoose is said ‘never to miss the mark’, which is probably more Rabelais’ comment on how Justice was made from post-hoc justifications for arbitrary decisions in equivocal cases.

The first recognizably modern approach to outcomes of dice games date to as early as the late fourteenth century in a commentary on Dante, where the commentator states that from three six sided dice the scores one and eighteen can only happen in only one way, but the scores four and seventeen can occur in two ways. The answer is incorrect, but is a way of thinking about outcomes which we still use today.

The mid-seventeenth century saw the detailed development of probability applied to games of chance with such figures as Pascal, Leibniz, Fermat, Huygens, Caramuel and de Méré. Franklin gives a good account of the interactions between these mathematicians in the mid-seventeenth century.

The final chapter is a discussion of the preceding chapters. A question that Franklin asks is given the knowledge of everyday probability why didn’t mathematical probability develop before the seventeenth century? The answer is fascinating with a multiplicity of causes ranging from the physiological to the logical.

Franklin then discusses the effect that reasoning about evidence and data used in law has had upon other disciplines including arithmetic, logic, geometry, ethics and infor-
mation theory. Franklin sees legal reasoning as a backdrop to all other thinking about uncertainty, indeed many of the major figures in the development of qualitative and quantitative probability were lawyers of some description. It could be argued that the pervasiveness of legal thinking was one of the factors which delayed the development of quantitative approaches to probabilistic reasoning.

Despite the ubiquity of legal thinking what is clear is that in the West there was remarkably little communication between the areas where ideas of uncertainty were used. This contrasts with the Jewish tradition where decisions made in law and decisions made about conduct would treat evidence in similar ways. In the West the fourteenth century scholastics worked in, and made advances in many separate fields, but they did not seem to look sideways into other areas such as money-lending and insurance for ideas on risk. The sixteenth century merchants, although possessed of tools which worked in the commercial arena, did not have their ideas taken up and adapted by religious leaders to resolve ethical problems, or lawyers to resolve legal problems. The problems seen with the inability of empirical data to influence theory in medicine were not addressed by the examination of lawyers techniques for deciding between contradictory propositions.

Most reasoning by humans is about outcomes which are uncertain, and few people have time, or the intellectual apparatus, to calculate quantitative probabilities for events in everyday life, if indeed the calculations can be made. This means that non-quantitative reasoning about events will be a feature of human existence for a long time to come, and that people will continue to make decisions on an informal analysis of the data available to them. The problem is that in the modern world formal mathematical modes of reasoning have come to dominate, with the less formal methods being to some extent neglected. People today have more and more decisions to make throughout the course of their lives than those in the past, and more data upon which to do it. Unfortunately there are fewer modes of informal reasoning for making those decisions. In some respects in the West we are worse off than in the fourteenth century, although the overall programme of work being taken by the artificial intelligence community may be able to make up for some of the deficit. There are other questions though. If in a criminal case one applies informal reasoning methods to evidence, as is mostly the case, has the
judicial process really been as fair as possible to both sides? The Science of Conjecture is a timely reminder that throughout history people have been able to take decisions and make rational judgments about events which are uncertain without the apparatus of mathematical probability.

Franklin states in the preface that he uses many quotes to allow the historical texts to speak for themselves. Normally this would not be a problem, but in this particular work there are so many short quotes that normal typesetting formats means it is difficult to easily distinguish between Franklin’s text and quoted text. Longer quotes, being indented, are easier on the eye. Franklin’s tendency to quote and offer explanation only in those passages which really need it make the text seem almost incoherent at points, with the reader puzzling over how one quote from a text relates to another. Obviously this is not intellectual indolence, and the author must draw the line at some point as to how much explanation to give, but a little more from Franklin would have been welcome. Similarly, because the treatments of uncertainty used in each chapter do not really relate to those in any other chapter, a short discussion at the end of each would be a useful addition which would allow readers to follow the debate whilst the subject matter is fresh in their minds. To some extent these criticisms are a result of Franklin’s commitment to allow the reader to make sense of the historical text as the authors wrote them. Unfortunately the process of abstraction and compilation is in itself a form of interpretation, thus adulteration cannot be totally avoided. Possibly a more satisfactory approach to a history of this nature may be that outlined by Collingwood (1946) where the historian acts as an interpreter, not to judge, but merely to make the ideas outlined in history coherent to the modern reader.

The *Science of Conjecture* has a unique combination of scope and depth, and should be read by all with a professional interest in the history of ideas. It is a thorough and ambitious work which tries, and largely succeeds, in bringing together pre-seventeenth century ideas of working with uncertainty. Despite some minor flaws, Franklin’s scholarship and insights manage to elevate this history from being a simple gazetteer to an invaluable reminder that human knowledge is not inevitably an accretive process. Instead much valuable learning is less familiar, if not wholly forgotten, to a modern audience than its
quality deserves. This is a book which fills that gap in the history of science between
history of philosophy on one hand, and the history of mathematics on the other; it does
however demand a careful and diligent reading.

References

Hacking, I. (1975) *The Emergence of Probability: A Philosophical Study of Early Ideas
about Probability, Induction and Statistical Inference*. Cambridge University Press.