

Contents

PREFACE XI

PROLOGUE XIII

Chapter 1
UNCERTAINTY 1

- 1.1. Introduction, 1
- 1.2. Examples, 2
- 1.3. Suppression of Uncertainty, 11
- 1.4. The Removal of Uncertainty, 13
- 1.5. The Uses of Uncertainty, 15
- 1.6. The Calculus of Uncertainty, 17
- 1.7. Beliefs, 18
- 1.8. Decision Analysis, 20

Chapter 2
STYLISTIC QUESTIONS 23

- 2.1. Reason, 23
- 2.2. Unreason, 26
- 2.3. Facts, 28
- 2.4. Emotion, 29
- 2.5. Normative and Descriptive Approaches, 31
- 2.6. Simplicity, 33
- 2.7. Mathematics, 35
- 2.8. Writing, 37
- 2.9. Mathematics Tutorial, 38

Chapter 3**PROBABILITY**

45

- 3.1. Measurement, 45
- 3.2. Randomness, 48
- 3.3. A Standard for Probability, 50
- 3.4. Probability, 52
- 3.5. Coherence, 54
- 3.6. Belief, 56
- 3.7. Complementary Event, 58
- 3.8. Odds, 60
- 3.9. Knowledge Base, 63
- 3.10. Examples, 66
- 3.11. Retrospect, 68

Chapter 4**TWO EVENTS**

69

- 4.1. Two Events, 69
- 4.2. Conditional Probability, 72
- 4.3. Independence, 75
- 4.4. Association, 77
- 4.5. Examples, 79
- 4.6. Supposition and Fact, 81
- 4.7. Seeing and Doing, 82

Chapter 5**THE RULES OF PROBABILITY**

85

- 5.1. Combinations of Events, 85
- 5.2. Addition Rule, 87
- 5.3. Multiplication Rule, 89
- 5.4. The Basic Rules, 92
- 5.5. Examples, 95
- 5.6. Extension of the Conversation, 98

- 5.7. Dutch Books, 101
- 5.8. Scoring Rules, 103
- 5.9. Logic Again, 105
- 5.10. Decision Analysis, 106
- 5.11. The Prisoners' Dilemma, 107
- 5.12. The Calculus and Reality, 110
- 5.13. Closure, 112

Chapter 6

BAYES RULE

113

- 6.1. Transposed Conditionals, 113
- 6.2. Learning, 116
- 6.3. Bayes Rule, 118
- 6.4. Medical Diagnosis, 119
- 6.5. Odds Form of Bayes Rule, 123
- 6.6. Forensic Evidence, 125
- 6.7. Likelihood Ratio, 127
- 6.8. Cromwell's Rule, 129
- 6.9. A Tale of Two Urns, 131
- 6.10. Ravens, 135
- 6.11. Diagnosis and Related Matters, 138
- 6.12. Information, 140

Chapter 7

MEASURING UNCERTAINTY

143

- 7.1. Classical Form, 143
- 7.2. Frequency Data, 145
- 7.3. Exchangeability, 147
- 7.4. Bernoulli Series, 151
- 7.5. De Finetti's Result, 152
- 7.6. Large Numbers, 154
- 7.7. Belief and Frequency, 157
- 7.8. Chance, 161

Chapter 8**THREE EVENTS**

165

- 8.1. The Rules of Probability, 165
- 8.2. Simpson's Paradox, 168
- 8.3. Source of the Paradox, 170
- 8.4. Experimentation, 171
- 8.5. Randomization, 173
- 8.6. Exchangeability, 176
- 8.7. Spurious Association, 181
- 8.8. Independence, 183
- 8.9. Conclusions, 186

Chapter 9**VARIATION**

189

- 9.1. Variation and Uncertainty, 189
- 9.2. Binomial Distribution, 191
- 9.3. Expectation, 195
- 9.4. Poisson Distribution, 197
- 9.5. Spread, 201
- 9.6. Variability as an Experimental Tool, 204
- 9.7. Probability and Chance, 206
- 9.8. Pictorial Representation, 208
- 9.9. Probability Densities, 212
- 9.10. The Normal Distribution, 213
- 9.11. Variation as a Natural Phenomenon, 217
- 9.12. Ellsberg's Paradox, 219

Chapter 10**DECISION ANALYSIS**

225

- 10.1. Beliefs and Actions, 225
- 10.2. Comparison of Consequences, 227
- 10.3. Medical Example, 231
- 10.4. Maximization of Expected Utility, 234

- 10.5. More on Utility, 236
- 10.6. Some Complications, 238
- 10.7. Reason and Emotion, 240
- 10.8. Numeracy, 242
- 10.9. Expected Utility, 245
- 10.10. Decision Trees, 246
- 10.11. The Art and Science of Decision Analysis, 249
- 10.12. Further Complications, 252
- 10.13. Combination of Features, 256
- 10.14. Legal Applications, 260

Chapter 11

SCIENCE

265

- 11.1. Scientific Method, 265
- 11.2. Science and Education, 266
- 11.3. Data Uncertainty, 268
- 11.4. Theories, 271
- 11.5. Uncertainty of a Theory, 276
- 11.6. The Bayesian Development, 278
- 11.7. Modification of Theories, 281
- 11.8. Models, 284
- 11.9. Hypothesis Testing, 287
- 11.10. Significance Tests, 291
- 11.11. Repetition, 293
- 11.12. Summary, 296

Chapter 12

EXAMPLES

299

- 12.1. Introduction, 299
- 12.2. Cards, 300
- 12.3. The Three Doors, 301
- 12.4. The Problem of Two Daughters, 305
- 12.5. Two More Daughters and Cardano, 309
- 12.6. The Two Envelopes, 313

- 12.7. Y2K, 316
- 12.8. UFOs, 317
- 12.9. Conglomerability, 321
- 12.10. Efron's Dice, 323

Chapter 13

PROBABILITY ASSESSMENT 327

- 13.1. Nonrepeatable Events, 327
- 13.2. Two Events, 329
- 13.3. Coherence, 333
- 13.4. Probabilistic Reasoning, 336
- 13.5. Trickle Down, 337
- 13.6. Summary, 341

Chapter 14

STATISTICS 343

- 14.1. Bayesian Statistics, 343
- 14.2. A Bayesian Example, 346
- 14.3. Frequency Statistics, 350
- 14.4. Significance Tests, 355
- 14.5. Betting, 360
- 14.6. Finance, 365

EPILOGUE 375

SUBJECT INDEX 383

INDEX OF EXAMPLES 391

INDEX OF NOTATIONS 393