

Contents

1. Sample Space and Probability	p. 1
1.1. Sets	p. 3
1.2. Probabilistic Models	p. 6
1.3. Conditional Probability	p. 18
1.4. Total Probability Theorem and Bayes' Rule	p. 28
1.5. Independence	p. 34
1.6. Counting	p. 44
1.7. Summary and Discussion	p. 51
Problems	p. 53
2. Discrete Random Variables	p. 71
2.1. Basic Concepts	p. 72
2.2. Probability Mass Functions	p. 74
2.3. Functions of Random Variables	p. 80
2.4. Expectation, Mean, and Variance	p. 81
2.5. Joint PMFs of Multiple Random Variables	p. 92
2.6. Conditioning	p. 97
2.7. Independence	p. 109
2.8. Summary and Discussion	p. 115
Problems	p. 119
3. General Random Variables	p. 139
3.1. Continuous Random Variables and PDFs	p. 140
3.2. Cumulative Distribution Functions	p. 148
3.3. Normal Random Variables	p. 153
3.4. Joint PDFs of Multiple Random Variables	p. 158
3.5. Conditioning	p. 164
3.6. The Continuous Bayes' Rule	p. 178

3.7. Summary and Discussion	p. 182
Problems	p. 184
4. Further Topics on Random Variables	p. 201
4.1. Derived Distributions	p. 202
4.2. Covariance and Correlation	p. 217
4.3. Conditional Expectation and Variance Revisited	p. 222
4.4. Transforms	p. 229
4.5. Sum of a Random Number of Independent Random Variables	p. 240
4.6. Summary and Discussion	p. 244
Problems	p. 246
5. Limit Theorems	p. 263
5.1. Markov and Chebyshev Inequalities	p. 265
5.2. The Weak Law of Large Numbers	p. 269
5.3. Convergence in Probability	p. 271
5.4. The Central Limit Theorem	p. 273
5.5. The Strong Law of Large Numbers	p. 280
5.6. Summary and Discussion	p. 282
Problems	p. 284
6. The Bernoulli and Poisson Processes	p. 295
6.1. The Bernoulli Process	p. 297
6.2. The Poisson Process	p. 309
6.3. Summary and Discussion	p. 324
Problems	p. 326
7. Markov Chains	p. 339
7.1. Discrete-Time Markov Chains	p. 340
7.2. Classification of States	p. 346
7.3. Steady-State Behavior	p. 352
7.4. Absorption Probabilities and Expected Time to Absorption	p. 362
7.5. Continuous-Time Markov Chains	p. 369
7.6. Summary and Discussion	p. 378
Problems	p. 380
8. Bayesian Statistical Inference	p. 407
8.1. Bayesian Inference and the Posterior Distribution	p. 412
8.2. Point Estimation, Hypothesis Testing, and the MAP Rule	p. 420
8.3. Bayesian Least Mean Squares Estimation	p. 430
8.4. Bayesian Linear Least Mean Squares Estimation	p. 437

8.5. Summary and Discussion	p. 444
Problems	p. 446
9. Classical Statistical Inference	p. 459
9.1. Classical Parameter Estimation	p. 462
9.2. Linear Regression	p. 477
9.3. Binary Hypothesis Testing	p. 486
9.4. Significance Testing	p. 496
9.5. Summary and Discussion	p. 505
Problems	p. 507
Index	p. 521