Probability and Statistics with Reliability, Queuing, and Computer Science Applications

Kishor Shridharbhai Trivedi

Duke University Durham, North Carolina



A Wiley-Interscience Publication JOHN WILEY & SONS, INC.

Contents

Preface to the Second Edition Preface to the First Edition				
1	Intr	oduction	, 1	
	1.1	Motivation	1	
	1.2	Probability Models	2	
	1.3	Sample Space	3	
	1.4	Events	6	
	1.5	Algebra of Events	7	
	1.6	Graphical Methods of Representing Events	11	
	1.7	Probability Axioms	13	
	1.8	Combinatorial Problems	19	
	1.9	Conditional Probability	23	
	1.10	Independence of Events	25	
	1.11	Bayes' Rule	38	
	1.12	Bernoulli Trials	45	
2	Disc	crete Random Variables	61	
	2.1	Introduction	61	
	2.2	Random Variables and Their Event Spaces	62	
	2.3	The Probability Mass Function	64	
	2.4	Distribution Functions	66	
	2.5	Special Discrete Distributions	68	
	2.6	Analysis of Program MAX	92	
	2.7	The Probability Generating Function	96	
	2.8	Discrete Random Vectors	99	
	2.9	Independent Random Variables	104	

vi CONTENTS

3	Co	ntinuous Random Variables 1	15
	3.1	Introduction	.15
	3.2	The Exponential Distribution	19
	3.3	The Reliability and Failure Rate	24
	3.4	Some Important Distributions	29
	3.5	Functions of a Random Variable	
	3.6	Jointly Distributed Random Variables	
	3.7	Order Statistics	
	3.8	Distribution of Sums	
	3.9	Functions of Normal Random Variables	
4	Ex	pectation 1	93
_	4.1	Introduction	_
	4.2	Moments	
	4.3	Expectation Based on Multiple Random Variables 2	
	4.4	Transform Methods	
	4.5	Moments and Transforms of Some Distributions	
	4.6	Computation of Mean Time to Failure	
	4.7	Inequalities and Limit Theorems	
	4.1	inequalities and Limit Theorems	31
5			47
	5.1	Introduction	
	5.2	Mixture Distributions	
	5.3	Conditional Expectation	
	5.4	Impefect Fault Coverage and Reliability	
	5.5	Random Sums	79
6	Sto		39
	6.1	Introduction	
	6.2	Classification of Stochastic Processes	
	6.3	The Bernoulli Process	
	6.4	The Poisson Process)4
	6.5	Renewal Processes	14
	6.6	Availability Analysis	19
	6.7	Random Incidence	28
	6.8	Renewal Model of Program Behavior	32
7	Disc	crete-Time Markov Chains 33	37
	7.1	Introduction	37
	7.2	Computation of <i>n</i> -step Transition Probabilities	11
	7.3	State Classification and Limiting Probabilities	
	7.4	Distribution of Times Between State Changes	
	7.5	Markov Modulated Bernoulli Process	
	7.6	Irreducible Finite Chains with Aperiodic States	
	7.7	* The $M/G/1$ Queuing System	

CONTENTS

D	Laplace Transforms			801
\mathbf{C}	Statistical Tables			780
В	Properties of Distributions			777
A	Bibliography A.1 Theory			
	11.6 Correlation Analysis	 		745 748 749
	11.1 Introduction			732 735 738
11	10.1 Introduction			639
10	Statistical Inference	•	•	637
	9.6 Computing Response Time Distribution			
	 9.3 Closed Queuing Networks			596
9	Networks of Queues 9.1 Introduction			560
	8.1 Introduction			412 446 454 496 520
8	7.9 Finite Markov Chains with Absorbing States	•	•	392 405
	7.8 Discrete-Time Birth-Death Processes			385

viii	CONTENTS	
\mathbf{E}	Program Performance Analysis	808
	Author Index	811
	Subject Index	819