

Contents

Preface	vi
Interdependence of Chapters and Sections	xiii
Notations and symbols	xiv
1 Coin tossing process	1
1.1 Borel's model of coin tossing process	1
1.2 Construction of random variables from coin tossing process	2
1.3 Simulatable random variable	4
1.3.1 Stopping time and simulatable random variable	4
1.3.2 \mathbb{T}^1 -valued uniform i.i.d. sequence as random source	6
2 Mathematical formulation of Monte Carlo method	9
2.1 Overview	9
2.2 Monte Carlo method as gambling	11
2.2.1 Player's aim	11
2.2.2 An exercise	12
2.3 Problem of random number	13
2.4 Pseudorandom generator	14
2.4.1 Definition and role	14
2.4.2 Security	14
2.4.3 Computationally secure pseudorandom generator	15
2.5 Monte Carlo integration	16
2.5.1 i.i.d.-sampling	16
2.5.2 Random Weyl sampling	17
2.6 From viewpoint of mathematical statistics	20
2.6.1 Random sampling	20
2.6.2 Test for pseudorandom generator	20
3 Random number	23
3.1 Partial recursive function	23
3.1.1 Primitive recursive function and partial recursive function	24
3.1.2 Kleene's normal form	25
3.1.3 Canonical order	26
3.1.4 Enumeration theorem and halting problem	27
3.2 Kolmogorov complexity and random number	30
3.3 Test and Martin-Löf's theorem	33

3.3.1	Formulation of test and universal test	34
3.3.2	Martin-Löf's theorem	36
3.4	Kolmogorov complexity and entropy	37
3.5	Infinite random sequence	39
3.6	Random number and probability theory	40
4	Pseudorandom generator	43
4.1	Computationally secure pseudorandom generator	43
4.1.1	Definitions	43
4.1.2	Computational security and Monte Carlo method	44
4.1.3	Existence problem	45
4.1.4	Next-bit-unpredictability	46
4.2	Pseudorandom generator by means of Weyl transformation	49
4.2.1	Definitions	49
4.2.2	Hardness of next-bit-prediction	50
4.2.3	Formula of finite dimensional distributions and disappearance of dependence	52
4.2.4	A priori estimate of finite dimensional distributions	54
4.3	Proofs of theorems	57
4.3.1	Proof of Lemma 4.12	57
4.3.2	Proof of Theorem 4.13	59
4.3.3	Proof of Theorem 4.15	65
4.3.4	Proof of Theorem 4.11	72
4.3.5	Precise estimate of exponential decay of two-term correlation	80
5	Monte Carlo integration	85
5.1	L^2 -robustness	85
5.2	Random Weyl sampling (Part 2)	88
5.2.1	Degeneration of CLT-scaling limit	88
5.2.2	RWS in case $m \gg 1$	91
5.2.3	Another example of pairwise independent random variables	95
5.3	i.i.d.-sampling for simulatable random variables	96
5.4	Dynamic random Weyl sampling	98
5.4.1	Definition and Theorem	98
5.4.2	Proof of Theorem 5.13	99
5.4.3	Algorithm	101
5.4.4	Comparison between i.i.d.-sampling and DRWS	102
5.4.5	Limit theorem for convergence of DRWS	103
6	Implementation	113
6.1	Implementation of RWS	113
6.1.1	Implementation of Example 2.9	113
6.1.2	Implementation of Example 5.9	114
6.2	C language library : <i>random_sampler</i>	115
6.2.1	Source code	116
6.2.2	Specification of constant and function	120

6.2.3	Sample codes	122
6.2.4	Restrictions of use	124
Closing remarks		125
Bibliography		127
Index		131

Interdependence of Chapters and Sections

