
CONTENTS

PREFACE	ix
1 THE ANNEALING ALGORITHM: A PREVIEW	1
1.1 Combinatorial optimization	1
1.2 Moves and local minima	5
1.3 Hill climbing	9
1.4 Simulated annealing	14
1.5 Applications	17
1.6 Mathematical model	19
1.7 Discussion	20
2 PRELIMINARIES FROM MATRIX THEORY	21
2.1 Matrices. Notation and basic properties	21
2.2 Pseudo-diagonal normal forms	25
2.3 Norms and limits of matrices	34
2.4 Quadratic forms	42
2.5 Discussion	46
3 CHAINS	47
3.1 Terminology	48
3.2 Linear arrangement, an example	50
3.3 The chain limit theorem	52
3.4 Reversible chains	59
3.5 Discussion	63

4	CHAIN STATISTICS	65
4.1	Density Functions	66
4.2	Expected values	68
4.3	Sampling	71
4.4	Maximum likelyhood densities	73
4.5	Aggregate functions	74
4.6	Discussion	78
5	ANNEALING CHAINS	79
5.1	Towards low scores	80
5.2	Maximal accessibility	86
5.3	The acceptance function	89
5.4	Properties of annealing chains	91
5.5	Discussion	93
6	SAMPLES FROM NORMAL DISTRIBUTIONS	95
6.1	Characteristic functions	95
6.2	Quadratic forms and characteristic functions	100
6.3	Sampling distributions	106
6.4	Asymptotic properties of sampling distributions	112
6.5	Discussion	113
7	SCORE DENSITIES	115
7.1	The density of states	115
7.2	Weak control	117
7.3	Strong control	119
7.4	Three parameter aggregates	122
7.5	Discussion	126
8	THE CONTROL PARAMETER	127
8.1	Initialization	128
8.2	Decrements in the control parameter	131
8.3	A stop criterion	135
8.4	Proper convergence	138
8.5	Discussion	139

9	FINITE-TIME BEHAVIOR OF THE ANNEALING ALGORITHM	141
9.1	Rate of convergence of chains	142
9.2	Minimum number of iterations	144
9.3	Finite-time optimal schedules	148
9.4	Discussion	150
10	THE STRUCTURE OF THE STATE SPACE	153
10.1	Chain convergence	154
10.2	The topography of the state space.	156
10.3	The set of moves	159
10.4	Global convergence	164
10.5	Discussion	165
11	IMPLEMENTATION ASPECTS	167
11.1	An implementation	167
11.2	The selection function	175
11.3	Other speed-up methods	176
	REFERENCES	179
	INDEX	195