

Contents

Preface	v
1 Introduction	1
1.1 Preliminaries	1
1.2 Dynamic Programming for TSP	4
1.3 A Branching Algorithm for Independent Set	7
2 Branching	13
2.1 Fundamentals	14
2.2 k -Satisfiability	18
2.3 Independent Set	23
3 Dynamic Programming	31
3.1 Basic Examples	32
3.1.1 Permutation Problems	32
3.1.2 Partition Problems	34
3.2 Set Cover and Dominating Set	36
3.3 TSP on Graphs of Bounded Degree	41
3.4 Partition into Sets of Bounded Cardinality	43
4 Inclusion-Exclusion	51
4.1 The Inclusion-Exclusion Principle	51
4.2 Some Inclusion-Exclusion Algorithms	53
4.2.1 Computing the Permanent of a Matrix	53
4.2.2 Directed Hamiltonian Path	56
4.2.3 Bin Packing	59
4.3 Coverings and Partitions	60
4.3.1 Coverings and Graph Coloring	61
4.3.2 Partitions	64
4.3.3 Polynomial Space Algorithms	66
4.4 Counting Subgraph Isomorphisms	68

5	Treewidth	77
5.1	Definition and Dynamic Programming	77
5.2	Graphs of Maximum Degree 3	81
5.3	Counting Homomorphisms	86
5.4	Computing Treewidth	91
5.4.1	Computing the Treewidth Using Potential Maximal Cliques	92
5.4.2	Counting Minimal separators and Potential Maximal Cliques	96
6	Measure & Conquer	101
6.1	Independent Set	102
6.2	Feedback Vertex Set	106
6.2.1	An Algorithm for Feedback Vertex Set	108
6.2.2	Computing a Minimum Feedback Vertex Set	109
6.3	Dominating Set	113
6.3.1	The Algorithm msc	114
6.3.2	A Measure & Conquer Analysis	116
6.4	Lower Bounds	120
7	Subset Convolution	125
7.1	Fast zeta Transform	126
7.2	Fast Subset Convolution	128
7.3	Applications and Variants	132
7.4	f -width and Rank-width	136
8	Local Search and SAT	141
8.1	Random Walks to Satisfying Assignments	142
8.2	Searching Balls and Cover Codes	146
9	Split and List	153
9.1	Sort and Search	153
9.2	Maximum Cut	158
10	Time Versus Space	161
10.1	Space for Time: Divide & Conquer	161
10.2	Time for Space: Memorization	166
11	Miscellaneous	171
11.1	Bandwidth	171
11.2	Branch & Recharge	175
11.3	Subexponential Algorithms and ETH	179
12	Conclusions, Open Problems and Further Directions	187
	References	189
	Appendix: Graphs	199

Index 201