

Contents

1	Basics I: Graphs	1
1.1	Introduction to graph theory	1
1.2	Excursion: Random graphs	9
2	Basics II: Algorithms	23
2.1	Introduction to algorithms	23
2.2	Excursion: Fibonacci heaps and amortized time	31
3	Basics III: Complexity	41
3.1	Introduction to complexity theory	42
3.2	Excursion: More NP-complete problems	51
4	Special Terminal Sets	63
4.1	The shortest path problem	63
4.2	The minimum spanning tree problem	66
4.3	Excursion: Matroids and the greedy algorithm	68
5	Exact Algorithms	75
5.1	The enumeration algorithm	76
5.2	The Dreyfus-Wagner algorithm	78
5.3	Excursion: Dynamic programming	81
6	Approximation Algorithms	87
6.1	A simple algorithm with performance ratio 2	88
6.2	Improving the time complexity	90
6.3	Excursion: Machine scheduling	95

7	More on Approximation Algorithms	107
7.1	Minimum spanning trees in hypergraphs	108
7.2	Improving the performance ratio I	116
7.3	Excursion: The complexity of optimization problems	121
8	Randomness Helps	133
8.1	Probabilistic complexity classes	133
8.2	Improving the performance ratio II	139
8.3	An almost always optimal algorithm	148
8.4	Excursion: Primality and cryptography	152
9	Limits of Approximability	165
9.1	Reducing optimization problems	165
9.2	APX-completeness	174
9.3	Excursion: Probabilistically checkable proofs	179
10	Geometric Steiner Problems	191
10.1	A characterization of rectilinear Steiner minimum trees	192
10.2	The Steiner ratios	199
10.3	An almost linear time approximation scheme	204
10.4	Excursion: The Euclidean Steiner problem	212
	Bibliography	223
	Index	233
	Symbol Index	241