

# Contents

<b>1</b>	<b>Discrete Problems from Applications</b>	<b>1</b>
<b>2</b>	<b>Basics, Notation and Data Structures</b>	<b>7</b>
2.1	Definition of a Graph	7
2.2	How to Represent a Graph on the Computer?	9
2.3	Basic Terminology from Graph Theory	10
2.4	Algorithms and Complexity	11
2.4.1	Correctness	13
2.4.2	Running Time	14
2.5	Two Graph Traversals	14
<b>3</b>	<b>Minimum Spanning Trees</b>	<b>19</b>
3.1	Minimum Connected Subgraphs	19
3.2	Trees	20
3.3	Minimum Spanning Trees	22
3.4	Kruskal's Algorithm	25
3.5	Prim's Algorithm	27
3.6	Remarks	29
3.7	Some Additional Notation	31
<b>4</b>	<b>Linear Programming Duality</b>	<b>33</b>
4.1	The MST-Polytope	33
4.2	Farkas' Lemma	41
4.3	Duality Theorem of Linear Programming	44
4.4	The Greedy as Primal-Dual Algorithm	48
4.5	The Base Polytope	50
<b>5</b>	<b>Shortest Paths</b>	<b>53</b>
5.1	Introduction	53
5.2	Dijkstra's Algorithm	54
5.3	Some Considerations about Implementations	56

5.4	Special Label Setting Methods for the Computation of Shortest Paths Between Two Vertices	56
5.5	Label Setting Versus Label Correcting	58
5.6	Detecting Negative Circuits	61
5.7	Application	63
5.8	An Analog Computer and LP Duality	64
<b>6</b>	<b>Maximal Flows</b>	<b>69</b>
6.1	Introduction	69
6.2	The Algorithm of Ford and Fulkerson	70
6.3	Max-Flow-Min-Cut	72
6.4	Pathologies	74
6.5	Edmonds-Karp Implementation	76
6.6	Max-flow-Min-cut as Linear Programming Duality	77
6.7	Preflow Push	79
6.8	Preflow Push Considered as a Dual Algorithm	83
6.9	FIFO-Implementation	85
<b>7</b>	<b>Minimum-Cost Flows</b>	<b>89</b>
7.1	Introduction	89
7.2	Optimality Criteria	90
7.3	First Algorithms	95
7.3.1	Canceling Negative Circuits, the Primal Method	95
7.3.2	Augmenting Shortest Paths, the Dual Method	96
7.4	The Primal Dual Method	98
7.5	Polynomial Time Algorithms	99
7.5.1	Min Mean Circuit Canceling	99
7.5.2	Capacity Rounding	103
7.5.3	Cost Scaling	104
<b>8</b>	<b>Matching</b>	<b>111</b>
8.1	Bipartite Matching	111
8.2	Augmenting Paths	117
8.3	Non-Bipartite Graphs	118
8.4	The Tutte-Berge Formula	125
<b>9</b>	<b>Weighted Matching</b>	<b>129</b>
9.1	Bipartite Weighted Matching	130
9.1.1	Inverse Minimum Spanning Tree Problem	137
9.2	Non-Bipartite Matching	137
9.2.1	The Matching Polytope	138
9.2.2	The Weighted Matching Algorithm	144
9.3	Karyotyping and the Chinese Postman Problem	150

- A Using Gato and Gred** ..... 155
  - A.1 Easy Installation ..... 155
  - A.2 Installing from Source ..... 156
  - A.3 The Gato Application ..... 157
    - A.3.1 Running Algorithms in Gato ..... 161
  - A.4 Gred ..... 163
    - A.4.1 Editing Graphs with Gred ..... 166
  
- B A Brief Introduction to Reading Python** ..... 169
  - B.1 Where to Obtain Python ..... 171
  
- C Visualizing Graph Algorithms with Gato** ..... 173
  - C.1 Interesting Events During Runtime ..... 173
  - C.2 Rule-Based Visualization ..... 175
  - C.3 Animated Data Structures (ADS) ..... 176
    - C.3.1 Case Study: Ford-Fulkerson Algorithm ..... 178
    - C.3.2 Implementation of Gato ..... 180
    - C.3.3 ADS Defined in Gato ..... 181
  
- References** ..... 185
  
- Index** ..... 187



<http://www.springer.com/978-3-540-14887-6>

CATBox

An Interactive Course in Combinatorial Optimization

Hochstättler, W.; Schliep, A.

2010, XII, 190 p., Softcover

ISBN: 978-3-540-14887-6