Contents

1 Transport in Freight Carrier Networks 1
1.1 Recent Trends in Freight Transportation 1
1.2 Carrier Transport Networks 4
1.3 Network Design, Configuration and Deployment 9
1.4 Distribution and Collection Planning 11
1.5 Aims of this Book and Used Methods 13

2 Operational Freight Transport Planning 15
2.1 Decision Problems 16
2.1.1 Request Acceptance 16
2.1.2 Mode Selection 17
2.1.3 Routing 19
2.1.4 Freight Optimization 20
2.2 Hierarchical and Simultaneous Planning 22
2.2.1 Hierarchical Approach 22
2.2.2 Simultaneous Routing and Freight Optimization 23
2.3 Generic Models for Simultaneous Problems 24
2.3.1 Maximal-Profit Selection 25
2.3.2 Bottleneck Selection 25
2.3.3 Selection with Compulsory Requests 26
2.3.4 Selection with Postponement 27
2.4 Conclusions 29

3 Pickup and Delivery Selection Problems 31
3.1 Problems with Pickup and Delivery Requests 31
3.1.1 Problems with Depot-Connected Requests 33
3.1.2 Problems with Direct Delivery Requests 33
3.1.3 Simultaneous Problems 34
3.2 Pickup and Delivery Paths and Schedules 34
3.3 Optimization Problem 36
3.4 Problem Variants 37

3.4.1 The PDSP with LSP Incorporation . . . 38
3.4.2 The Capacitated PDSP . . . 39
3.4.3 The PDSP with Compulsory Requests . . . 39
3.4.4 The PDSP with Postponement . . . 40
3.5 Test Case Generation . . . 42
3.5.1 Generation of Pickup and Delivery Requests . . . 42
3.5.2 Freight Tariff . . . 45
3.5.3 Benchmark Suites . . . 46
3.6 Conclusions . . . 48

4 Memetic Algorithms . . . 49
4.1 Algorithmic Solving of Problems with PD-Requests . . . 49
4.2 Evolutionary Algorithms . . . 52
4.3 Genetic Algorithms . . . 55
4.3.1 Terminus Technici . . . 55
4.3.2 General Framework . . . 56
4.3.3 Applicability of Genetic Search . . . 57
4.3.4 Limits of the Genetic Search . . . 58
4.4 Repairing and Improving the Genetic Code . . . 60
4.5 Conclusions . . . 64

5 Memetic Algorithm Vehicle Routing . . . 65
5.1 Genetic Sequencing . . . 65
5.2 Genetic Clustering . . . 68
5.3 Combined Genetic Sequencing and Clustering . . . 71
5.4 Advanced MA-Approaches: The State-of-the-Art . . . 71
5.4.1 Multi-Chromosome Memetic Algorithms . . . 72
5.4.2 Co-Evolution with Specialization . . . 74
5.4.3 Co-Evolution of Partial Solutions . . . 75
5.5 Conclusions . . . 76

6 Memetic Search for Optimal PD-Schedules . . . 77
6.1 Permutation-Controlled Schedule Construction . . . 78
6.1.1 Construction of Routes for more than one Vehicle . . . 78
6.1.2 Parallel Time-Window-Based Routing . . . 78
6.1.3 Algorithm Steps . . . 79
6.1.4 Determination of the Request Instantiation Order . . . 84
6.2 Representation of a PD-Schedule . . . 84
6.3 Configuration of the Memetic Algorithm . . . 85
6.3.1 Initial Population . . . 85
6.3.2 Recombination . . . 86
6.3.3 Mutation . . . 90
6.3.4 Population Model . . . 92
6.4 Computational Experiments . . . 93
6.4.1 Parameterization of the MA . . . 94

6.4.2 Impacts of Spatial Distribution and Time Window Tightness . . . 97
6.4.3 Identification of Profit-Maximum Request Selections . . . 100
6.4.4 Consideration of Capacity Limitations . . . 102
6.4.5 Identification of Deferrable Requests . . . 109
6.5 Conclusions . . . 113

7 Coping with Compulsory Requests . . . 115
7.1 Limits of Fitness Penalization . . . 116
7.1.1 Static Penalties . . . 116
7.1.2 Dynamically Determined Penalties . . . 118
7.1.3 Adaptive Penalization . . . 119
7.2 A Double-Ranking Approach . . . 120
7.3 Converging-Constraint Approach . . . 121
7.3.1 Alternating and Converging Constraints . . . 121
7.3.2 ACC-Algorithm Control . . . 124
7.4 Assessing QC-MA and ACC-MA: Numerical Results . . . 125
7.4.1 Experimental Setup . . . 125
7.4.2 Numerical Results . . . 125
7.4.3 Impacts of Intermediate Cost Reductions: An Example . . . 130
7.5 Conclusions . . . 133

8 Request Selection and Collaborative Planning . . . 135
8.1 The Portfolio Re-composition Problem . . . 136
8.1.1 Literature Review . . . 136
8.1.2 Formal Problem Statement . . . 137
8.2 Configuration of the Groupage System . . . 139
8.2.1 Bundle Specification by the Carriers . . . 140
8.2.2 Bundle Assignment by the Mediator . . . 140
8.3 Computational Experiments . . . 141
8.3.1 Test Cases . . . 142
8.3.2 Collaborative Planning Approach . . . 142
8.3.3 Reference Approach . . . 143
8.3.4 Results . . . 143
8.4 Conclusions . . . 147

9 Conclusions . . . 149
9.1 Understanding Freight Carrier Decision Problems . . . 149
9.2 Model Building . . . 150
9.3 Methodological. Enhancements . . . 151

References . . . 153

Index . . . 161