
CONTENTS

PREFACE

ix

1	OVERVIEW OF HIERARCHICAL MULTIOBJECTIVE ANALYSIS	1
1.1	Introduction	1
1.2	Hierarchical Multiobjective Coordination	3
1.3	Multiple Decisionmakers	4
1.4	Dynamic HMO Models	4
1.5	Hierarchical Overlapping Coordination	5
1.6	Hierarchical Holographic Modeling	6
1.7	Who Should Benefit from This Book	7
2	OVERVIEW OF MULTIOBJECTIVE OPTIMIZATION	9
2.1	Introduction	9
2.2	Examples of Multiple Environmental Objectives	10
2.3	SWT Method	14
2.4	SWT Method and Utility Function Approach	25
2.5	Example Problems	31
	References	38

3 OVERVIEW OF HIERARCHICAL ANALYSIS	41
3.1 Introduction	41
3.2 Attributes of Decomposition and Multilevel Optimization	42
3.3 General Hierarchical Structures	44
3.4 Hierarchical Modeling	46
3.5 General Problem Formulation	48
3.6 General Formulation of an Overlapping Decomposition	52
3.7 Feasible and Nonfeasible Decomposition	53
References	67
4 HIERARCHICAL METHODS OF GENERATING PARETO OPTIMAL ALTERNATIVES	69
4.1 Introduction	69
4.2 Displaying Pareto Optimal Alternatives	70
4.3 Review of Basic Results in Generating Methods	70
4.4 Mathematical Formulation of Large-Scale Multicriteria Problems with Multiple Decisionmakers	76
4.5 Varying the Number of Decisionmakers	79
4.6 Case $N + 1$: Pareto Optimality of All Objectives	80
4.7 Case 1: Pareto Optimality of Overall Objectives	81
4.8 Case N : Pareto Optimality of Subsystem Objectives	84
4.9 Summary	114
References	115
5 HIERARCHICAL METHODS FOR DETERMINING PREFERRED SOLUTIONS	117
5.1 Introduction	117
5.2 General Necessary Condition for the Preferred Solution	119
5.3 Mathematical Problem Formulation	121
5.4 Necessary Conditions for the Large-Scale Problem	122
5.5 Feasible Methods	126
5.6 Nonfeasible Methods	133
5.7 Extensions to Basic Schemes	137
5.8 Numerical Examples	138
5.9 Interaction between Analyst and Decisionmaker	148
References	151
6 MULTIPLE DECISIONMAKERS	153
6.1 Introduction	153
6.2 Stackelberg Scheme	153
6.3 Negotiations with Indifference Trade-Offs	154
6.4 Negotiations with Trade-Offs	155
References	164

7 DISCRETE DYNAMIC MODELS	165
7.1 Introduction	165
7.2 Problem Formulation	165
7.3 Straightforward Approach	167
7.4 Two-Point Boundary Value Method	172
7.5 Hierarchical Methods	174
7.6 Discussion of the Methods	177
References	178
8 MULTIOBJECTIVE DYNAMIC PROGRAMMING	179
8.1 Introduction	179
8.2 Problem Formulation	179
8.3 Algorithms for Determining Preferred Solutions	180
8.4 Algorithm for Determining Pareto Optimal Alternatives	184
References	186
9 HIERARCHICAL OVERLAPPING COORDINATION: SINGLE-OBJECTIVE MODELS	189
9.1 Introduction	189
9.2 Concept of HOC	189
9.3 Mathematical Formulation of HOC	194
9.4 Convergence Properties of HOC	201
9.5 Example	209
References	216
10 INTEGRATION OF HIERARCHICAL OVERLAPPING COORDINATION IN MULTIOBJECTIVE OPTIMIZATION PROBLEMS	219
10.1 Introduction	219
10.2 Multiobjective Hierarchical Overlapping Coordination (MHOC) Appendix: Direct Derivation of Coordination Equation from the Trade-Off Relationships	222
References	257
11.1 Water Resources Management Problem	261
11.2 Management Planning for an Industrial Organization	273
References	297
11 EXAMPLES OF INTEGRATION OF HIERARCHICAL OVERLAPPING COORDINATION WITH MULTIOBJECTIVE OPTIMIZATION	261

12 HIERARCHICAL HOLOGRAPHIC MODELING	299
12.1 Introduction	299
12.2 Mathematical Formulation	300
12.3 Pareto Optimal Solution Generation Scheme	309
References	317
AUTHOR INDEX	319
SUBJECT INDEX	321