

CONTENTS

PREFACE	xiii
1. INTRODUCTION	1
1.0 Motivation / 1	
1.1 History / 3	
1.2 First Principles / 7	
1.3 Planning Context / 10	
1.4 Role of GIS / 12	
1.5 Summary / 14	
1.6 Terms / 15	
1.7 References / 15	
1.8 Exercises / 15	
2. GIS	19
2.0 Introduction / 19	
2.1 Data Acquisition / 26	
2.1.1 Existing Sources / 26	
2.1.2 Semiexisting Sources / 27	
2.1.3 Surveying and Airborne Approaches / 28	
2.2 Data Management / 29	
2.2.1 Raster / 29	
2.2.2 Vector / 32	

vi CONTENTS

2.3	Data Manipulation / 33	
2.3.1	Conversion / 33	
2.3.2	Aggregation / 36	
2.3.3	Overlay / 36	
2.3.4	Interpolation / 40	
2.4	Data Analysis / 41	
2.4.1	Query / 41	
2.4.2	Proximity / 42	
2.4.3	Centrality / 44	
2.4.4	Service Zone / 44	
2.5	Data Display / 47	
2.6	Summary / 51	
2.7	Terms / 52	
2.8	References / 53	
2.9	Exercises / 53	
3.	MODEL-BUILDING FUNDAMENTALS	55
3.0	Introduction / 55	
3.1	Review of Mathematical Notation / 55	
3.1.1	Variables / 56	
3.1.2	Mathematical Expressions / 56	
3.1.3	Inequalities / 58	
3.2	Formulating an Optimization Model / 59	
3.2.1	Apple Shipment / 59	
3.2.2	Manufacturing Plant Location / 61	
3.2.3	School Consolidation / 64	
3.3	Model Solution / 69	
3.3.1	Apple Shipment Application / 70	
3.3.2	Manufacturing Plant Location Application / 72	
3.3.3	School Consolidation Application / 74	
3.4	Summary / 78	
3.5	Terms / 79	
3.6	References / 79	
3.7	Exercises / 79	
4.	TRADE AND SERVICE AREAS	81
4.0	Introduction / 81	
4.1	Problem Definition and Motivation / 82	

4.1.1	Descriptive Trade Area / 82	
4.1.2	Prescriptive Service Area / 83	
4.2	Mathematical Representation / 84	
4.2.1	Descriptive Trade Area / 84	
4.2.2	Prescriptive Service Area / 88	
4.3	GIScience / 90	
4.4	Modeling Application / 95	
4.4.1	Descriptive Trade Area / 95	
4.4.2	Prescriptive Service Area / 96	
4.5	Advanced Topics / 100	
4.5.1	Spatial Interaction Considerations / 101	
4.5.2	Transportation Problem Considerations / 102	
4.5.3	Using Trade and Service Area Models in Site Selection / 104	
4.6	Summary / 105	
4.7	Terms / 105	
4.8	References / 105	
4.9	Exercises / 106	
5.	SUITABILITY ANALYSIS	107
5.0	Introduction / 107	
5.1	Problem Definition and Motivation / 107	
5.2	Suitability Assessment Process / 109	
5.2.1	Absolute Suitability / 113	
5.2.2	Relative Suitability / 115	
5.3	GIScience / 116	
5.3.1	Map Algebra / 118	
5.3.2	Attribute Data Measurement / 119	
5.4	Model Application / 121	
5.4.1	Absolute Suitability / 121	
5.4.2	Relative Suitability / 123	
5.5	Advanced Topics / 126	
5.6	Summary / 130	
5.7	Terms / 132	
5.8	References / 132	
5.9	Exercises / 133	
6.	POINT-BASED LOCATION	135
6.0	Introduction / 135	

viii CONTENTS

6.1	Problem Definition and Motivation / 136	
6.2	Mathematical Representation / 138	
6.2.1	Formulating the Weber Problem / 138	
6.2.2	Iterative Solution Approach for the Weber Problem / 139	
6.3	GIScience / 141	
6.3.1	Projections and Coordinate Systems / 142	
6.3.2	Spherical Distance / 143	
6.3.3	Planar Distance / 145	
6.4	Modeling Application / 146	
6.4.1	Solution Using Commercial Software / 148	
6.4.2	Iterative Solution / 149	
6.5	Advanced Topics / 150	
6.5.1	Variants of Planar Single Facility Location / 151	
6.5.2	Fallacy of the Centroid / 152	
6.5.3	Location on a Sphere / 153	
6.5.4	Continuously Distributed Demand / 153	
6.6	Summary / 155	
6.7	Terms / 156	
6.8	References / 156	
6.9	Exercises / 156	
7.	LINE-BASED LOCATION	159
7.0	Introduction / 159	
7.1	Motivation and Problem Definition / 160	
7.2	Mathematical Representation / 161	
7.2.1	Shortest-Path Model / 162	
7.2.2	Exact Solution Approach / 165	
7.3	GIScience / 166	
7.3.1	Defining the Network / 168	
7.4	Modeling Application / 172	
7.4.1	Path / 172	
7.4.2	Corridor Siting in ArcGIS / 176	
7.5	Advanced Topics / 177	
7.5.1	Expanding the Network / 178	
7.5.2	Shortest-Path Variants / 181	
7.6	Summary / 184	
7.7	Terms / 184	

7.8	References / 185	
7.9	Exercises / 185	
8.	AREA-BASED LOCATION	187
8.0	Introduction / 187	
8.1	Problem Definition and Motivation / 187	
8.2	Mathematical Representation / 188	
8.2.1	Knapsack Model / 189	
8.2.2	Threshold Model / 190	
8.2.3	Shape Model / 191	
8.3	GIScience / 194	
8.4	Modeling Application / 196	
8.4.1	Knapsack Model Application / 197	
8.4.2	Threshold Model Application / 199	
8.4.3	Shape Model Application / 199	
8.5	Advanced Topics / 203	
8.6	Summary / 205	
8.7	Terms / 206	
8.8	References / 206	
8.9	Exercises / 206	
9.	COVERAGE	209
9.0	Introduction / 209	
9.1	Problem Definition and Motivation / 210	
9.1.1	Complete Coverage / 211	
9.1.2	Maximal Coverage / 212	
9.2	Mathematical Representation / 212	
9.2.1	Complete Coverage / 213	
9.2.2	Maximal Coverage / 215	
9.3	GIScience / 216	
9.4	Modeling Application / 218	
9.4.1	LSCP / 219	
9.4.2	MCLP / 220	
9.5	Advanced Topics / 222	
9.5.1	Backup Coverage / 223	
9.5.2	Service Availability / 225	
9.5.3	Spatial Representation / 227	
9.6	Summary / 230	

x CONTENTS

- 9.7 Terms / 231
- 9.8 References / 231
- 9.9 Exercises / 231

10. DISPERSION **235**

- 10.0 Introduction / 235
- 10.1 Problem Definition and Motivation / 236
- 10.2 Mathematical Representation / 237
 - 10.2.1 Neighborhood Restrictions / 239
 - 10.2.2 Pairwise Restrictions / 240
 - 10.2.3 Clique Restrictions / 241
- 10.3 GIScience / 243
- 10.4 Modeling Application / 244
 - 10.4.1 Neighborhood Restrictions / 246
 - 10.4.2 Pairwise Restrictions / 248
 - 10.4.3 Clique Restrictions / 251
- 10.5 Advanced Topics / 252
 - 10.5.1 Hybrid Restrictions / 253
 - 10.5.2 Max-Min-Min Dispersion / 254
- 10.6 Summary / 256
- 10.7 Terms / 256
- 10.8 References / 257
- 10.9 Exercises / 257

11. LOCATION-ALLOCATION **259**

- 11.0 Introduction / 259
- 11.1 Problem Definition and Motivation / 260
- 11.2 Mathematical Representation / 260
 - 11.2.1 Heuristic Solution / 263
- 11.3 GIScience / 265
- 11.4 Modeling Application / 267
- 11.5 Advanced Topics / 272
 - 11.5.1 Continuous Space Siting / 273
 - 11.5.2 Service Capacities and Fixed Costs / 274
 - 11.5.3 Accounting for Uncertainty and Error / 276
- 11.6 Summary / 277
- 11.7 Terms / 278
- 11.8 References / 278
- 11.9 Exercises / 278

12. CONCLUSION	281
12.0 Introduction /	281
12.1 Classes of Location Models /	281
12.2 Class Variety and Extensions /	282
12.3 Solution Approaches /	285
12.4 Final Thoughts /	288
12.5 References /	289
GLOSSARY	291
INDEX	301

