

CONTENTS

Preface

xiii

1	Social Networks and Blockmodels	1
1.1	An Intuitive Statement of Network Ideas	3
1.1.1	Fundamental Types of Social Relations	5
1.1.2	Types of Relational Data Arrays	11
1.2	Blocks as Parts of Networks	11
1.2.1	Blocks	12
1.3	Some Block Types	14
1.4	Specifying Blockmodels	16
1.4.1	Parent–Child Role Systems	16
1.4.2	Organizational Hierarchies	17
1.4.3	Systems of Ranked Clusters	19
1.4.4	Baboon Grooming Networks	20
1.5	Conventional Blockmodeling	24
1.5.1	Equivalence and Blockmodeling	24
1.6	Generalized Blockmodeling	25
1.7	An Outline Map of the Topics Considered	27
2	Network Data Sets	30
2.1	Classic Data Sets	30
2.1.1	Sampson Monastery Data	31
2.1.2	Bank Wiring Room Data	37
2.1.3	Newcomb Fraternity Data	44
2.2	Newer Data Sets	47
2.2.1	Little League Baseball Teams	47
2.2.2	Political Actor Network	50
2.2.3	Student Government Data	52
2.2.4	Kansas Search and Rescue Network	54
2.2.5	A Bales-Type Group Dynamics Network	56

2.2.6	Ragusan Families Marriage Networks	56
2.2.7	Two Baboon Grooming Networks	60
2.3	Data Set Properties	61
2.4	Some Additional Remarks Concerning Data	63
3	Mathematical Prelude	64
3.1	Basic Set Theory	64
3.2	Relations	70
3.2.1	Operations with Binary Relations	74
3.2.2	Comparing Relations	76
3.2.3	Special Operations	80
3.3	Functions	84
3.3.1	Products of Functions \odot	87
3.3.2	Relational Homomorphisms	88
3.4	Basic Algebra \odot	89
3.5	Transitions to Chapters 4 and 9	93
4	Relations and Graphs for Network Analysis	94
4.1	Graphs	94
4.1.1	Examples of Graphs	104
4.1.2	Traveling on a Graph	107
4.1.3	Graph Coloring	111
4.2	Types of Binary Relations	112
4.2.1	Properties of Relations	113
4.2.2	Closures	114
4.2.3	Computing the Transitive Closure \triangleright	115
4.2.4	Special Elements	116
4.2.5	Tournaments \triangleright	117
4.3	Partitions and Equivalence Relations	117
4.4	Acyclic Relations	122
4.4.1	Levels	123
4.5	Orders	124
4.5.1	Factorization	125
4.5.2	Hasse Diagram	126
4.5.3	Numberings	127
4.6	Networks	127
4.7	Centrality in Networks	128
4.7.1	Algorithmic Aspects	131
4.8	Summary and Transition	131
5	Clustering Approaches	133
5.1	An Introduction to Cluster Analytic Ideas	133
5.2	Usual Clustering Problems	134
5.2.1	An Example	135
5.2.2	The Usual Steps of Solving Clustering Problems	137

5.3	(Dis)similarities	137
5.3.1	(Dis)similarity Measures for Numerical Data	138
5.3.2	(Dis)similarity Measures for Binary Data	142
5.4	Clustering Algorithms	143
5.4.1	The Hierarchical Approach	144
5.4.2	The Leader Algorithm	149
5.4.3	The Relocation Algorithms	150
5.5	Constrained Clustering	150
5.5.1	The Constrained Clustering Problem	151
5.5.2	Solving Constrained Clustering Problems	154
5.5.3	The Structure Enforcement Coefficient	156
5.5.4	An Empirical Example	156
5.6	Multicriteria Clustering	160
5.6.1	A Multicriteria Clustering Problem	160
5.6.2	Solving Discrete Multicriteria Optimization Problems	161
5.6.3	Direct Multicriteria Clustering Algorithms	161
5.6.4	An Example	164
5.7	Transition to Blockmodeling	167
6	An Optimizational Approach to Conventional Blockmodeling	168
6.1	Conventional Blockmodeling	168
6.1.1	Definitions of Equivalences	170
6.1.2	Equivalence and k -Partite Graphs	176
6.1.3	Establishing Conventional Blockmodels	176
6.1.4	The Indirect Blockmodeling Approach	177
6.1.5	Measuring the Equivalence of Pairs of Units	178
6.2	Optimization and Blockmodeling	184
6.2.1	The Direct Blockmodeling Approach	185
6.2.2	A Criterion for Structural Equivalence	186
6.2.3	A Criterion for Regular Equivalence	187
6.2.4	A Clustering Algorithm	188
6.2.5	Two Artificial Examples	188
6.3	Representing Partitions	192
6.4	Some Empirical Examples	196
6.4.1	Two Little League Baseball Teams	196
6.4.2	The Political Actor Example	201
6.5	An Analysis of a Search and Rescue Operation	203
6.6	Generalized Blockmodeling	209
7	Foundations for Generalized Blockmodeling	210
7.1	Generalization of Equivalences	211
7.1.1	Some Properties of the Predicates	213
7.1.2	Examples	215

7.2	Generalized Blockmodeling	220
7.2.1	Blockmodels	220
7.2.2	\mathcal{T} -Equivalence	222
7.2.3	Optimization	223
7.3	Two Examples of Generalized Blockmodeling	227
7.3.1	An Artificial Network	227
7.3.2	A Student Government Network	228
7.3.3	Exploring Multiple Partitions	231
7.4	Prespecified Blockmodels	233
7.5	Blockmodel Types	235
7.6	Applications of Prespecified Blockmodels	237
7.6.1	Classroom Liking Ties for Boys and Girls	237
7.6.2	Baboon Grooming Networks	238
7.6.3	Multiple Blockmodels and Inconsistencies	243
7.7	Some Benefits of the Optimization Approach	245
7.8	Extending Generalized Blockmodeling	245
8	Blockmodeling Two-Mode Network Data	247
8.1	Two-Mode Network Data	247
8.2	Approaches to Two-Mode Network Data	248
8.3	Blockmodels for Two-Mode Network Data	249
8.4	A Formalization of Blockmodeling Two-Mode Data	250
8.5	Blockmodels with Empirical Data	251
8.5.1	Supreme Court Voting	251
8.5.2	The Southern Women Event Participation Data	257
8.5.3	Journal-to-Journal Citation Networks	265
8.6	Summary	270
9	Semirings and Lattices	271
9.1	Walks, Paths, and Algebras	271
9.2	Distributivity and Absorption	273
9.2.1	Distributivity	274
9.2.2	Absorption	274
9.3	Valued Graphs	274
9.3.1	Assigning Values to Paths	275
9.3.2	Assessing Paths in Terms of Their Values	276
9.4	Semirings	279
9.4.1	Some Social Network Applications of Semirings	282
9.5	Semilattices and Lattices as Relations	285
9.5.1	Bounds	286
9.5.2	Semilattices and Lattices	287
9.6	Algebraic View on Lattices	290
9.6.1	Types of Lattices	291
9.6.2	Representations	293
9.7	Conclusion	294

10	Balance Theory and Blockmodeling Signed Networks	295
10.1	Structural Balance Theory	296
10.2	Signed Networks	297
10.3	Partitioning Signed Networks and Semirings	299
10.3.1	Examples	301
10.4	A Partitioning Algorithm for Signed Networks	302
10.5	Exactly k -Balanced Structures	304
10.5.1	An Empirical Example	306
10.6	Structures That are Not k -Balanced	307
10.6.1	A Constructed Example	307
10.6.2	An Empirical Example	307
10.7	Another Look at the Bank Wiring Room Data	310
10.8	Balance and Imbalance in a Bales Group	312
10.9	Through-Time Balance Processes	317
10.9.1	The Sampson Data	318
10.9.2	The Newcomb Data	320
10.10	Blockmodeling and Signed Networks	324
11	Symmetric–Acyclic Blockmodels	326
11.1	Blocks for Directed Graphs and Acyclic Graphs	326
11.2	Two Constructed Examples	327
11.3	Establishing Symmetric–Acyclic Decompositions of Networks	328
11.3.1	Ideal Structures	328
11.3.2	Relations without a Symmetric–Acyclic Decomposition	331
11.4	Liking Ties for Children in a Classroom	333
11.5	The Student Government Example	337
11.5.1	A Hypothesized Blockmodel	337
11.5.2	A Second Hypothesized Blockmodel	338
11.6	A Return to the Classroom Example	339
11.7	Marriage Network of the Ragusan Noble Families	340
11.7.1	Network Decomposition	341
11.7.2	Blockmodeling Approach	344
11.8	Discussion	346
12	Extending Generalized Blockmodeling	347
12.1	Block Types	347
12.2	Block Types and Criterion Functions	348
12.3	Using Substantive and Empirical Knowledge	349
12.3.1	Prespecification	349
12.3.2	Constraints	350
12.3.3	Imposing Penalties	350
12.4	The Magnitudes of Criterion Functions	350
12.5	The Generalized Blockmodeling Framework	352
12.6	Composition of Blocks	354

12.7	Multiple Fitted Blockmodels	355
12.8	Multiple Relations	356
12.9	Other Networks and Network Types	358
12.10	Network Size and Valued Graphs	360
<i>Bibliography</i>		363
<i>Author Index</i>		375
<i>Subject Index</i>		378