

# Contents

Acknowledgements	xiii
Preface	xv
Online resources	xix

## 1 Introduction

1.1 Why networks?	1
1.2 What are networks?	1
1.3 Types of relations	2
1.4 Goals of analysis	4
1.5 Network variables as explanatory variables	7
1.6 Network variables as outcome variables	8
1.7 Summary	10
1.8 Problems and Exercises	11

## 2 Mathematical Foundations

2.1 Introduction	13
2.2 Graphs	13
2.3 Paths and components	16
2.4 Adjacency matrices	20
2.5 Ways and modes	22
2.6 Matrix products	24
2.7 Summary	25
2.8 Problems and Exercises	25

## 3 Research Design

3.1 Introduction	29
3.2 Experiments and field studies	29
3.3 Whole-network and personal-network research designs	30
3.4 Sources of network data	33
3.5 Types of nodes and types of ties	34
	35



3.6 Actor attributes	38
3.7 Sampling and bounding	38
3.8 Sources of data reliability and validity issues	41
3.9 Ethical considerations	46
3.10 Summary	49
3.11 Problems and Exercises	49
<b>4 Data Collection</b>	<b>51</b>
4.1 Introduction	51
4.2 Network questions	52
4.3 Question formats	54
4.4 Interviewee burden	60
4.5 Data collection and reliability	61
4.6 Archival data collection	63
4.7 Data from electronic sources	66
4.8 Summary	70
4.9 Problems and Exercises	70
<b>5 Data Management</b>	<b>71</b>
5.1 Introduction	71
5.2 Data import	71
5.3 Cleaning network data	79
5.4 Data transformation	80
5.5 Normalization	92
5.6 Cognitive social structure data	93
5.7 Matching attributes and networks	94
5.8 Converting attributes to matrices	96
5.9 Data export	98
5.10 Summary	99
5.11 Problems and Exercises	99
<b>6 Multivariate Techniques Used in Network Analysis</b>	<b>103</b>
6.1 Introduction	103
6.2 Multidimensional scaling	103
6.3 Correspondence analysis	106
6.4 Hierarchical clustering	110
6.5 Summary	113
6.6 Problems and Exercises	113



7	Visualization	115
7.1	Introduction	115
7.2	Layout	116
7.3	Embedding node attributes	121
7.4	Node filtering	122
7.5	Ego networks	123
7.6	Embedding tie characteristics	126
7.7	Visualizing network change	132
7.8	Exporting visualizations	138
7.9	Closing comments	139
7.10	Summary	139
7.11	Problems and Exercises	140
8	Testing Hypotheses	143
8.1	Introduction	143
8.2	Permutation tests	144
8.3	Dyadic hypotheses	147
8.4	Mixed dyadic-monadic hypotheses	152
8.5	Node-level hypotheses	157
8.6	Whole-network hypotheses	158
8.7	Exponential random graph models	159
8.8	Stochastic actor-oriented models (SAOMs)	166
8.9	Summary	169
8.10	Problems and Exercises	169
9	Characterizing Whole Networks	173
9.1	Introduction	173
9.2	Cohesion	174
9.3	Reciprocity	179
9.4	Transitivity and the clustering coefficient	179
9.5	Triad census	181
9.6	Centralization and core-periphery indices	184
9.7	Summary	186
9.8	Problems and Exercises	186
10	Centrality	189
10.1	Introduction	189
10.2	Basic concept	190



10.3 Undirected, non-valued networks	191
10.4 Directed, non-valued networks	202
10.5 Valued networks	206
10.6 Negative tie networks	206
10.7 Summary	208
10.8 Problems and Exercises	208
<b>11 Subgroups</b>	<b>211</b>
11.1 Introduction	211
11.2 Cliques	213
11.3 Girvan-Newman algorithm	221
11.4 Factions and modularity optimization	223
11.5 Directed and valued data	228
11.6 Computational considerations	230
11.7 Performing a cohesive subgraph analysis	231
11.8 Supplementary material	236
11.9 Summary	237
11.10 Problems and Exercises	237
<b>12 Equivalence</b>	<b>239</b>
12.1 Introduction	239
12.2 Structural equivalence	240
12.3 Profile similarity	243
12.4 Blockmodels	248
12.5 The direct method	251
12.6 Regular equivalence	253
12.7 The REGE algorithm	255
12.8 Core-periphery models	258
12.9 Summary	264
12.10 Problems and Exercises	264
<b>13 Analyzing Two-mode Data</b>	<b>267</b>
13.1 Introduction	267
13.2 Converting to one-mode data	269
13.3 Converting valued two-mode matrices to one-mode	275
13.4 Bipartite networks	275
13.5 Cohesive subgroups and community detection	278
13.6 Core-periphery models	280
13.7 Equivalence	282



13.8 Summary	286
13.9 Problems and Exercises	286
14 Large Networks	289
14.1 Introduction	289
14.2 Reducing the size of the problem	290
14.3 Choosing appropriate methods	296
14.4 Sampling	300
14.5 Small-world and scale-free networks	302
14.6 Summary	303
14.7 Problems and Exercises	304
15 Ego Networks	305
15.1 Introduction	305
15.2 Personal-network data collection	307
15.3 Analyzing ego network data	314
15.4 Example 1 of an ego network study	322
15.5 Example 2 of an ego network study	326
15.6 Summary	328
15.7 Problems and Exercises	329
Glossary	331
References	349
Index	357