

Contents

1	Introduction	1
2	Maximum-Entropy Ensembles of Graphs	7
2.1	Constructing Constrained Graph Ensembles: Why and How?	7
2.1.1	Definition and Importance of Local Constraints	10
2.1.2	Computational Approaches	13
2.1.3	Analytical Approaches	16
2.2	The Maximum-Entropy Method	18
2.2.1	Maximum-Likelihood Parameter Estimation	22
2.2.2	A First Worked-Out Example: Binary, Undirected Networks with Constrained Degree Sequence	24
2.2.3	A Second Worked-Out Example: Weighted, Undirected Networks with Constrained Strength Sequence	25
2.3	Comparing Models Obtained from Different Constraints	27
	References	29
3	Pattern Detection	33
3.1	Detecting Assortativity and Clustering	34
3.1.1	Undirected Networks	34
3.1.2	Directed Networks	39
3.2	Detecting Dyadic Motifs	43
3.2.1	Reciprocity	45
3.3	Detecting Triadic Motifs	47
3.4	Some Extensions to Weighted Networks	53
3.4.1	Weighted Assortativity and Clustering	53
3.4.2	Weighted Reciprocity	55
3.4.3	A Model for Weighted Networks with Reciprocity	59
	References	61

4 Network Reconstruction 63

4.1 Reconstructing Network Properties from Partial Information 64

4.1.1 Reconstruction of Binary Networks 65

4.1.2 Naive Extension to Weighted Networks and Its
Limitations 65

4.2 The Enhanced Configuration Model. 69

4.2.1 In-Depth Example: Reconstructing
the World Trade Web 74

4.3 Further Reducing the Observational Requirements 82

4.3.1 Bootstrap Method 82

4.3.2 The Degree-Corrected Gravity Model 83

References 87

5 Graph Combinatorics 89

5.1 A Dual Route to Combinatorics? 90

5.2 ‘Soft’ Combinatorial Enumeration 91

5.3 Quantifying Ensemble (non)equivalence. 92

5.3.1 Marginal Equivalence 93

5.3.2 Fluctuating Constraints. 97

5.3.3 Measure Equivalence 98

5.4 Breaking of Equivalence Between Ensembles. 101

5.5 Implications of (non)equivalence for Combinatorics 106

5.6 “*What Then Shall We Choose?*” Hardness or Softness? 107

References 107

6 Concluding Remarks 109

References 112

Index 115



<http://www.springer.com/978-3-319-69436-8>

Maximum-Entropy Networks

Pattern Detection, Network Reconstruction and Graph
Combinatorics

Squartini, T.; Garlaschelli, D.

2017, XII, 116 p. 34 illus., 31 illus. in color., Softcover

ISBN: 978-3-319-69436-8