

Contents

1	Models and Systems: The Lowry Model as an Example	1
1.1	Models and Their Uses	1
1.2	Systems of Interest and Their Representation	2
1.2.1	System Representation	2
1.2.2	Urban and Regional Systems	2
1.2.3	The Lowry Model	3
1.2.4	Formal System Description and Accounts	8
	Reference	11
	Further Reading	11
2	The Retail Model and Its Applications	13
2.1	The Retail Model	13
2.2	Disaggregation	15
2.3	Structural Dynamics	16
2.4	An Urban Systems Example	16
	Further Reading	20
3	Wars, Epidemics, Ecology and the Evolution of Spatial Structure: Connecting Models Through Generalisation	21
3.1	Introduction	21
3.2	The Richardson ‘Arms Race’ Model	22
3.3	The Lotka-Volterra Prey-Predator Model	22
3.4	The Lotka-Volterra, Lanchester, Gause ‘Competition for Resources’ Model: Ecology and War	23
3.5	The Kermack-McKendrick Epidemics ‘Threshold’ Model	24
3.6	The Harris-Wilson Model of Urban Development	24
3.7	The Bass ‘Marketing’ Model	25
3.8	A General Model	25
3.9	A Lotka-Volterra Prey-Predator Model with Space	26

3.10	An Epstein-Lanchester-Lotka-Volterra ‘War’ Model with Space	27
3.11	Morphogenetic Models	27
	References	31
	Further Reading	31
4	Theory	33
4.1	Introduction.	33
4.2	Core Concepts by Discipline	33
4.2.1	Demography	33
4.2.2	Economics	35
4.2.3	Geography	36
4.2.4	Other Social Sciences.	39
4.2.5	History	39
4.2.6	The Physical Environment	39
4.2.7	Mathematics and Statistics	40
4.3	Interdisciplinary Theory Building.	40
	References	40
	Further Reading	41
5	Methods: The Model-Building Tool Kit	43
5.1	Introduction.	43
5.2	Account-Based Frameworks	43
5.2.1	Introduction	43
5.2.2	Demographic Models	44
5.2.3	Economic Input–Output Models	45
5.2.4	A Family of Spatial Interaction Models	46
5.2.5	Location Models	47
5.3	Mathematical Tools	48
5.3.1	Generic Approaches.	48
5.3.2	Basics	48
5.3.3	Mathematical Programming	49
5.3.4	Network Analysis	50
5.3.5	Rule-Based Representations	52
5.3.6	Combinations	53
	References	53
	Further Reading	53
6	Adding Depth-1: Spatial Interaction and the Location of Activities	55
6.1	Introduction.	55
6.2	Model Building Design Decisions	55
6.3	Applications	56
6.3.1	The Range	56

6.3.2	Interpretations	56
6.4	Derivations of the Core Spatial Interaction Model	56
6.4.1	Entropy Maximising	56
6.4.2	A Family of Models	59
6.4.3	Indicators	59
6.4.4	Disaggregation	61
6.4.5	Mathematical Programming Formulations.	61
6.4.6	Random Utility Theory and Related Economic Models	62
6.4.7	Other Formulations	63
6.5	Testing	63
6.6	Concluding Comment.	64
	References	64
	Further Reading	65
7	Adding Depth-2: Structural Dynamics	67
7.1	The Retail Model as an Example.	67
7.2	Agent Based Modelling Approaches.	73
7.3	Further Developments	76
	References	76
	Further Reading	76
8	Tools for Complexity Science	77
8.1	The ‘Complexity’ Thesis	77
8.2	New Challenges, New Tools	78
8.3	Will Complexity Science Succeed?	79
	References	80
	Further Reading	80
9	Research Challenges	81
9.1	Introduction.	81
9.2	Expanding the Conceptual Tool Kit	81
9.2.1	Example-1: Alonso–Herbert–Stevens–Senior–Wilson	82
9.2.2	Example-2: Fujita–Krugman–Venables.	84
9.3	Expanding the Methods Tool Kit.	85
9.3.1	Example-3: A Maths-Stats Challenge.	85
9.4	Information Systems-1: Representations and Scales	86
9.4.1	Example-4: The 10^{13} Issue	87
9.4.2	Example-5: Using Geodemographics in a BLV System	87
9.4.3	Example-6: Representing Multi-Level Systems	88
9.5	Modelling Challenges-1: Understanding Nonlinear Systems	91
9.5.1	Example-7: Unpicking the Mechanisms of Phase Change.	91

9.5.2	Example-8: An Extended Dynamic Model	93
9.5.3	Example-9: To Explore and Integrate the Range of Models that Generate Structure	93
9.5.4	Example-10: ‘DNA’ and Typologies of Cities.	93
9.6	Modelling Challenges-2: Extending the Range	94
9.6.1	Example-11: Hierarchical Retail Models	95
9.6.2	Example-12: The Evolution of Networks	96
9.6.3	Example-13: The Fry–Wilson ‘Global Dynamics’ Demonstration Model	99
9.7	Planning with Models.	99
9.8	Information Systems-2: Grand Designs.	100
9.9	Concluding Comments	101
	References	101
	Further Reading	102

The Science of Cities and Regions
Lectures on Mathematical Model Design

Wilson, A.

2012, XII, 102 p. 31 illus., Softcover

ISBN: 978-94-007-2265-1