

Contents

Contributors

ix

Preface

xi

1. Introduction

1

Yoshiki Yamagata and Hajime Seya

1.1 The definition of spatial data

1

1.2 Characteristics of spatial data: spatial autocorrelation and spatial heterogeneity

3

References

5

Part One Methods

7

2. Mathematical preparation

9

Hajime Seya and Yoshiki Yamagata

2.1 Definitions of notations

9

2.2 The classical linear regression model

10

2.3 The generalized linear model

17

2.4 The additive model

19

2.5 The basics of Bayesian statistics

23

References

30

3. Global and local indicators of spatial associations

33

Hajime Seya

3.1 Spatial weight matrix

33

3.2 Testing for spatial autocorrelation

39

3.3 Testing for spatial heterogeneity

51

References

53

4. Geostatistics and Gaussian process models

57

Daisuke Murakami, Yoshiki Yamagata and Toshihiro Hirano

4.1 What is geostatistics?

58

4.2 Geostatistical model

59

4.3 Parameter estimation

69

4.4 Kriging

76

4.5 Universal Kriging

81

4.6	Extended model	90
4.7	Hierarchical Bayesian model	95
4.8	Spatiotemporal model	99
4.9	Methods for large data	102
	References	107
5.	Spatial econometric models	113
	Hajime Seya, Takahiro Yoshida <i>and</i> Yoshiki Yamagata	
5.1	What is spatial econometrics?	114
5.2	Spatial econometric models	115
5.3	Parameter estimation of the spatial econometric models	122
5.4	Testing spatial autocorrelation based on the spatial econometric models	131
5.5	Testing spatial heterogeneity based on the spatial econometric models	135
5.6	Related methods	137
5.7	Methods for large data	143
	References	152
6.	Models in quantitative geography	159
	Daisuke Murakami <i>and</i> Yoshiki Yamagata	
6.1	Introduction	159
6.2	Geographically weighted regression models	160
6.3	Spatial filtering approach	169
6.4	Methods for large data	174
	References	176
Part Two	Implementations	179
7.	Implementation with R language	181
	Takahiro Yoshida <i>and</i> Daisuke Murakami	
7.1	Implementation of spatial (geo-)statistical and spatial econometric methods with R	182
7.2	Housing price data in Lucas County (Ohio, USA)	182
7.3	R package for spatial features: sf	184
7.4	Global and local indicators of spatial associations	186
7.5	Geostatistics	192
7.6	Spatial econometrics	202
7.7	Quantitative geography	210
	References	

Part Three Applications	225
8. Spatial heat-wave assessments using geotagged Twitter data	227
Daisuke Murakami <i>and</i> Yoshiki Yamagata	
8.1 Introduction	227
8.2 Geotagged Twitter data	230
8.3 Spatial field reconstruction of intraurban high-resolution temperature profiles using heat-tweet geotagged Twitter data	233
8.4 Application to temperature interpolation	235
8.5 Concluding remarks	237
References	237
9. Evaluating walkability using mobile GPS data	239
Yoshiki Yamagata, Daisuke Murakami <i>and</i> Takahiro Yoshida	
9.1 Introduction	239
9.2 Data and methods	240
9.3 Estimation results	246
9.4 Individual level walkability evaluation considering heat-wave stress	246
9.5 Discussion and concluding remarks	254
References	255
10. Spatial scenario creation based on downscale methods	259
Daisuke Murakami <i>and</i> Yoshiki Yamagata	
10.1 Introduction	259
10.2 Downscaling approach	260
10.3 Downscaling results	266
10.4 Concluding remarks	269
References	269
11. Quasi real-time energy use estimation using Google's Popular Times data	271
Takahiro Yoshida <i>and</i> Yoshiki Yamagata	
11.1 Introduction	271
11.2 Materials and methods	272
11.3 Estimation results	276
11.4 Concluding remarks	279
References	279
<i>Index</i>	<i>281</i>