

Contents

Preface	ix
Abdourrahmane M. ATTO, Francesca BOVOLO and Lorenzo BRUZZONE	
List of Notations	xiii
Chapter 1. Hierarchical Markov Random Fields for High Resolution Land Cover Classification of Multisensor and Multiresolution Image Time Series	1
Ihsen HEDHLI, Gabriele MOSER, Sebastiano B. SERPICO and Josiane ZERUBIA	
1.1. Introduction	1
1.1.1. The role of multisensor data in time series classification	1
1.1.2. Multisensor and multiresolution classification	2
1.1.3. Previous work	5
1.2. Methodology	9
1.2.1. Overview of the proposed approaches	9
1.2.2. Hierarchical model associated with the first proposed method ..	10
1.2.3. Hierarchical model associated with the second proposed method ..	13
1.2.4. Multisensor hierarchical MPM inference	14
1.2.5. Probability density estimation through finite mixtures	17
1.3. Examples of experimental results	19
1.3.1. Results of the first method	19
1.3.2. Results of the second method	22
1.4. Conclusion	26

1.5. Acknowledgments	26
1.6. References	27
Chapter 2. Pixel-based Classification Techniques for Satellite Image Time Series	33
Charlotte PELLETIER and Silvia VALERO	
2.1. Introduction	33
2.2. Basic concepts in supervised remote sensing classification	35
2.2.1. Preparing data before it is fed into classification algorithms	35
2.2.2. Key considerations when training supervised classifiers	39
2.2.3. Performance evaluation of supervised classifiers	41
2.3. Traditional classification algorithms	45
2.3.1. Support vector machines	45
2.3.2. Random forests	51
2.3.3. k -nearest neighbor	56
2.4. Classification strategies based on temporal feature representations	59
2.4.1. Phenology-based classification approaches	60
2.4.2. Dictionary-based classification approaches	61
2.4.3. Shapelet-based classification approaches	62
2.5. Deep learning approaches	63
2.5.1. Introduction to deep learning	64
2.5.2. Convolutional neural networks	68
2.5.3. Recurrent neural networks	71
2.6. References	75
Chapter 3. Semantic Analysis of Satellite Image Time Series	85
Corneliu Octavian DUMITRU and Mihai DATCU	
3.1. Introduction	85
3.1.1. Typical SITS examples	89
3.1.2. Irregular acquisitions	90
3.1.3. The chapter structure	96
3.2. Why are semantics needed in SITS?	96
3.3. Similarity metrics	97
3.4. Feature methods	98
3.5. Classification methods	98
3.5.1. Active learning	99
3.5.2. Relevance feedback	100
3.5.3. Compression-based pattern recognition	100
3.5.4. Latent Dirichlet allocation	101
3.6. Conclusion	102

3.7. Acknowledgments	105
3.8. References	105
Chapter 4. Optical Satellite Image Time Series Analysis for Environment Applications: From Classical Methods to Deep Learning and Beyond	109
Matthieu MOLINIER, Jukka MIETTINEN, Dino IENCO, Shi QIU and Zhe ZHU	
4.1. Introduction	109
4.2. Annual time series	111
4.2.1. Overview of annual time series methods	111
4.2.2. Examples of annual times series analysis applications for environmental monitoring	112
4.2.3. Towards dense time series analysis	116
4.3. Dense time series analysis using all available data	117
4.3.1. Making dense time series consistent	118
4.3.2. Change detection methods	121
4.3.3. Summary and future developments	125
4.4. Deep learning-based time series analysis approaches	126
4.4.1. Recurrent Neural Network (RNN) for Satellite Image Time Series	129
4.4.2. Convolutional Neural Networks (CNN) for Satellite Image Time Series	131
4.4.3. Hybrid models: Convolutional Recurrent Neural Network (ConvRNN) models for Satellite Image Time Series	134
4.4.4. Synthesis and future developments	136
4.5. Beyond satellite image time series and deep learning: convergence between time series and video approaches	136
4.5.1. Increased image acquisition frequency: from time series to spaceborne time-lapse and videos	137
4.5.2. Deep learning and computer vision as technology enablers	138
4.5.3. Future steps	139
4.6. References	140
Chapter 5. A Review on Multi-temporal Earthquake Damage Assessment Using Satellite Images	155
Gülşen TAŞKIN, Esra ERTEN and Enes Oğuzhan ALATAŞ	
5.1. Introduction	155
5.1.1. Research methodology and statistics	159
5.2. Satellite-based earthquake damage assessment	165
5.3. Pre-processing of satellite images before damage assessment	167
5.4. Multi-source image analysis	168

5.5. Contextual feature mining for damage assessment	169
5.5.1. Textural features	170
5.5.2. Filter-based methods	173
5.6. Multi-temporal image analysis for damage assessment	175
5.6.1. Use of machine learning in damage assessment problem	176
5.6.2. Rapid earthquake damage assessment	180
5.7. Understanding damage following an earthquake using satellite-based SAR	181
5.7.1. SAR fundamental parameters and acquisition vector	185
5.7.2. Coherent methods for damage assessment	188
5.7.3. Incoherent methods for damage assessment	192
5.7.4. Post-earthquake-only SAR data-based damage assessment	195
5.7.5. Combination of coherent and incoherent methods for damage assessment	196
5.7.6. Summary	198
5.8. Use of auxiliary data sources	200
5.9. Damage grades	200
5.10. Conclusion and discussion	203
5.11. References	205
 Chapter 6. Multiclass Multilabel Change of State Transfer Learning from Image Time Series	223
Abdourrahmane M. ATTO, Héla HADHRI, Flavien VERNIER and Emmanuel TROUVÉ	
6.1. Introduction	223
6.2. Coarse- to fine-grained change of state dataset	225
6.3. Deep transfer learning models for change of state classification	232
6.3.1. Deep learning model library	232
6.3.2. Graph structures for the CNN library	234
6.3.3. Dimensionalities of the learnables for the CNN library	236
6.4. Change of state analysis	237
6.4.1. Transfer learning adaptations for the change of state classification issues	238
6.4.2. Experimental results	239
6.5. Conclusion	243
6.6. Acknowledgments	244
6.7. References	244
 List of Authors	247
 Index	249
 Summary of Volume 1	253