

Contents

Foreword	ix
Preface	xi
1 Introduction to Bayesian networks	1
1.1 Models	1
1.2 Probabilistic vs. deterministic models	5
1.3 Unconditional and conditional independence	9
1.4 Bayesian networks	11
2 Medical diagnosis	15
2.1 Bayesian networks in medicine	15
2.2 Context and history	17
2.3 Model construction	19
2.4 Inference	26
2.5 Model validation	28
2.6 Model use	30
2.7 Comparison to other approaches	31
2.8 Conclusions and perspectives	32
3 Clinical decision support	33
3.1 Introduction	33
3.2 Models and methodology	34
3.3 The Busselton network	35
3.4 The PROCAM network	40
3.5 The PROCAM Busselton network	44
3.6 Evaluation	46
3.7 The clinical support tool: TakeHeartII	47
3.8 Conclusion	51
4 Complex genetic models	53
4.1 Introduction	53
4.2 Historical perspectives	54
4.3 Complex traits	56
4.4 Bayesian networks to dissect complex traits	59

4.5	Applications	64
4.6	Future challenges	71
5	Crime risk factors analysis	73
5.1	Introduction	73
5.2	Analysis of the factors affecting crime risk	74
5.3	Expert probabilities elicitation	75
5.4	Data preprocessing	76
5.5	A Bayesian network model	78
5.6	Results	80
5.7	Accuracy assessment	83
5.8	Conclusions	84
6	Spatial dynamics in France	87
6.1	Introduction	87
6.2	An indicator-based analysis	89
6.3	The Bayesian network model	97
6.4	Conclusions	109
7	Inference problems in forensic science	113
7.1	Introduction	113
7.2	Building Bayesian networks for inference	116
7.3	Applications of Bayesian networks in forensic science	120
7.4	Conclusions	126
8	Conservation of marbled murrelets in British Columbia	127
8.1	Context/history	127
8.2	Model construction	129
8.3	Model calibration, validation and use	136
8.4	Conclusions/perspectives	147
9	Classifiers for modeling of mineral potential	149
9.1	Mineral potential mapping	149
9.2	Classifiers for mineral potential mapping	151
9.3	Bayesian network mapping of base metal deposit	157
9.4	Discussion	166
9.5	Conclusions	171
10	Student modeling	173
10.1	Introduction	173
10.2	Probabilistic relational models	175
10.3	Probabilistic relational student model	176
10.4	Case study	180
10.5	Experimental evaluation	182
10.6	Conclusions and future directions	185

11	Sensor validation	187
11.1	Introduction	187
11.2	The problem of sensor validation	188
11.3	Sensor validation algorithm	191
11.4	Gas turbines	197
11.5	Models learned and experimentation	198
11.6	Discussion and conclusion	202
12	An information retrieval system	203
12.1	Introduction	203
12.2	Overview	205
12.3	Bayesian networks and information retrieval	206
12.4	Theoretical foundations	207
12.5	Building the information retrieval system	215
12.6	Conclusion	223
13	Reliability analysis of systems	225
13.1	Introduction	225
13.2	Dynamic fault trees	227
13.3	Dynamic Bayesian networks	228
13.4	A case study: The Hypothetical Sprinkler System	230
13.5	Conclusions	237
14	Terrorism risk management	239
14.1	Introduction	240
14.2	The Risk Influence Network	250
14.3	Software implementation	254
14.4	Site Profiler deployment	259
14.5	Conclusion	261
15	Credit-rating of companies	263
15.1	Introduction	263
15.2	Naive Bayesian classifiers	264
15.3	Example of actual credit-ratings systems	264
15.4	Credit-rating data of Japanese companies	266
15.5	Numerical experiments	267
15.6	Performance comparison of classifiers	273
15.7	Conclusion	276
16	Classification of Chilean wines	279
16.1	Introduction	279
16.2	Experimental setup	281
16.3	Feature extraction methods	285
16.4	Classification results	288
16.5	Conclusions	298

- 17 Pavement and bridge management 301**
 - 17.1 Introduction 301
 - 17.2 Pavement management decisions 302
 - 17.3 Bridge management 307
 - 17.4 Bridge approach embankment – case study 308
 - 17.5 Conclusion 312

- 18 Complex industrial process operation 313**
 - 18.1 Introduction 313
 - 18.2 A methodology for Root Cause Analysis 314
 - 18.3 Pulp and paper application 321
 - 18.4 The ABB Industrial IT platform 325
 - 18.5 Conclusion 326

- 19 Probability of default for large corporates 329**
 - 19.1 Introduction 329
 - 19.2 Model construction 332
 - 19.3 BayesCredit 335
 - 19.4 Model benchmarking 341
 - 19.5 Benefits from technology and software 342
 - 19.6 Conclusion 343

- 20 Risk management in robotics 345**
 - 20.1 Introduction 345
 - 20.2 DeepC 346
 - 20.3 The ADVOCATE II architecture 352
 - 20.4 Model development 354
 - 20.5 Model usage and examples 360
 - 20.6 Benefits from using probabilistic graphical models 361
 - 20.7 Conclusion 362

- 21 Enhancing Human Cognition 365**
 - 21.1 Introduction 365
 - 21.2 Human foreknowledge in everyday settings 366
 - 21.3 Machine foreknowledge 369
 - 21.4 Current application and future research needs 373
 - 21.5 Conclusion 375

- 22 Conclusion 377**
 - 22.1 An artificial intelligence perspective 377
 - 22.2 A rational approach of knowledge 379
 - 22.3 Future challenges 384

- Bibliography 385**

- Index 427**