

Contents

Part I Introduction

1	Introduction	3
1.1	Overview	3
1.1.1	Purpose and Organisation of the Book	3
1.1.2	Concise Overview	5
1.1.3	Nonmonotonic Logics	8
1.1.4	Basic Definitions - Chapter 2	10
1.1.5	Inheritance Systems - Chapter 3	11
1.1.6	Reiter Defaults - Chapter 4	14
1.1.7	Preferential Structures - Chapter 5	14
1.1.8	Algebraic and Structural Semantics	16
1.1.9	Deontic Logic - Chapter 6	18
1.1.10	Theory Revision, Update and Counterfactuals: Chapter 7	19
1.1.11	Neurology - Chapter 8	21
1.1.12	Interpolation - Chapter 9	22
1.1.13	Independence - Chapter 10	37
1.1.14	Formal Construction - Chapter 11	41
1.1.15	Kal Vachomer - Chapter 12	44
1.1.16	Equational CTD - Chapter 13	47
1.2	Introduction to the Main Concepts	52
1.2.1	Overview of This Section	52
1.2.2	Logic and Neuroscience	52
1.2.3	Concepts and Properties	54
1.2.4	Language and Language Change	57
1.2.5	Modularity and Independence	58
1.2.6	Main Concepts and Connections	58
1.2.7	Abstract Constructions	61
1.3	Previously Published Material	61

Part II Background Material

2	Basic Algebraic and Logical Definitions	65
2.1	Overview of This Chapter	65
2.2	The Definitions	66
3	Defeasible Inheritance	75
3.1	Summary	75
3.2	Conceptual Analysis	75
3.3	Basic Discussion	76
3.3.1	(Defeasible or Nonmonotonic) Inheritance Networks or Diagrams	76
3.3.2	Preclusion	79
3.4	Directly Sceptical Split Validity Upward Chaining Off-Path Inheritance	80
3.4.1	The Definition of \models (i.e. of Validity of Paths)	83
3.5	Review of Other Approaches and Problems	87
3.5.1	Extension-Based Versus Directly Sceptical Definitions	88
3.5.2	On-Path Versus Off-Path Preclusion	88
3.5.3	Split Validity Versus Total Validity Preclusion	88
3.6	Discussion of Their Properties in Our Context	89
4	Reiter Defaults and Autoepistemic Logic	91
4.1	Reiter Defaults	91
4.2	Autoepistemic Logic	94
4.3	Discussion of the Properties in Our Context	94
5	Preferential Structures and Related Concepts	97
5.1	Summary	97
5.2	Preferential Structures	98
5.2.1	The Minimal Variant	98
5.2.2	The Limit Variant	106
5.3	Laws About Size	109
5.3.1	Defaults as Generalised Quantifiers	109
5.3.2	Additive Laws About Size	110
5.3.3	Multiplicative Laws About Size	113
5.3.4	Hamming Relations and Distances	123
5.3.5	Summary of Properties	127
5.4	A Short Discussion of Their Abstract Properties in Our Context	130
6	Deontic Logic, Contrary-to-Duty Obligations	131
6.1	Summary	131
6.2	Deontic Logic	131
6.3	Contrary-to-Duty Obligations	132

6.4	<i>A</i> -Ranked Structures	133
6.4.1	Representation Results for <i>A</i> -Ranked Structures	133
6.5	Application of <i>A</i> -Ranked Structures to Contrary-to-Duty Conditionals	136
6.5.1	Outline of the Solution	136
6.5.2	Formal Modelling and Summary of Results	139
6.5.3	Overview	141
6.5.4	Formal Results and Representation for Hierarchical Conditionals	142
7	Theory Revision, Theory Contraction and Conditionals	145
7.1	Summary	145
7.2	Theory Revision	145
7.3	Theory Contraction	155
7.3.1	Introduction	155
7.3.2	Some of the AGM Axioms for Theory Contraction	155
7.3.3	The General Picture of Safe Contraction	156
7.3.4	A Modification	156
7.3.5	The Differences to Our Situation	157
7.4	Conditionals and Update	157
8	Neurology	159
8.1	Introduction and Summary	159
8.1.1	Summary	159
8.2	General Remarks on the Functioning of the Brain	160
8.2.1	Difference Between the Brain and Computers	160
8.2.2	Further Remarks	160
8.3	Summary of Work by Edelman et al.	162
8.3.1	Edelman's Research History	162
8.3.2	Terminology	163
8.3.3	The Main Ideas	164
8.3.4	Edelman's Theory in More Detail	165
8.3.5	Comments, and Our Own Ideas	169
8.4	Abstract Constructions—Another Part of Human Reasoning	172
8.5	Some Speculative Remarks About Prototypes	173
 Part III New Results		
9	Independence and Interpolation	177
9.1	Summary	177
9.2	Monotone and Antitone Interpolation	178
9.2.1	Overview and Background	178
9.2.2	Monotone and Antitone Semantic Interpolation	178
9.3	Interpolation for Nonmonotonic Logic and Size	181
9.3.1	Introduction	181

9.3.2	Some General and Combinatorial Results	183
9.3.3	Conditions for Abstract Multiplication and Generating Relations.	185
9.3.4	Some Examples.	190
9.3.5	Interpolation and $(\mu * 1)$	194
9.3.6	$(\mu * 1)$ and Interpolation for Equivalent Formulas . . .	196
9.3.7	Interpolation and $(\mu * 4)$	198
10	Probabilistic and Abstract Independence.	201
10.1	Summary	201
10.2	Introduction, Basic Definitions, and Notation	202
10.2.1	Probabilistic Independence	202
10.2.2	Set and Function Independence	204
10.3	Discussion of Some Simple Examples and Connections.	205
10.3.1	$X \times Z$	206
10.3.2	$X \times Z \times W$	207
10.3.3	$X \times Y \times Z$	208
10.3.4	$X \times Y \times Z \times W$	208
10.4	Basic Results for Set and Function Independence.	210
10.5	New Rules, Examples and Discussion for Function Independence	212
10.5.1	Example of a Rule Derived from the Basic Rules	213
10.5.2	More New Rules	215
10.6	There Is No Finite Characterisation for Function Independence	218
10.6.1	Discussion	219
10.6.2	Composition of Layers	219
10.6.3	Systematic Construction	220
10.6.4	The Cases to Consider.	221
10.6.5	Solution of the Cases.	222
10.6.6	Final Argument	223
10.7	Systematic Construction of New Rules for Function Independence	224
10.7.1	Consequences of a Single Triple	224
10.7.2	Construction of Function Trees	225
10.7.3	Examples.	226
11	Formal Construction	233
11.1	Summary	233
11.2	Discussion of Various Properties	236
11.2.1	Inference Pressure	236
11.2.2	Remarks on Various Systems	239
11.2.3	Further Properties	242

- 11.3 Desiderata 243
 - 11.3.1 Overall Aim 243
 - 11.3.2 Situation 243
 - 11.3.3 Rare Influence Changes and Its Consequences 245
 - 11.3.4 Varia 247
- 11.4 The Solution 247
 - 11.4.1 The Construction 251
- 11.5 Discussion 254
 - 11.5.1 General Remarks 254
 - 11.5.2 Rarity and Its Coding by Inheritance 255
 - 11.5.3 Modularity 258
 - 11.5.4 Graceful Degradation and Coherence 258
 - 11.5.5 Core and Extensions 259
 - 11.5.6 Contradictions 259
 - 11.5.7 Philosophy of Science 259
 - 11.5.8 The Different Aspects of Our Construction 260
 - 11.5.9 Modifications 260
 - 11.5.10 Aspects Not Considered 261
- 11.6 Extensions 262
 - 11.6.1 “Repairing” Properties 262
 - 11.6.2 Theory Revision 262
 - 11.6.3 Properties with Many Influences 263
 - 11.6.4 Language Fragments 263
- 11.7 Formal Properties 264
 - 11.7.1 A General Remark 265
- 12 The Talmudic Kal Vachomer Rule 267**
 - 12.1 Summary 267
 - 12.2 Introduction 268
 - 12.2.1 The Problem 268
 - 12.2.2 Historical Origin 269
 - 12.3 The AGS Approach 270
 - 12.3.1 Description 270
 - 12.3.2 A Problem with the Original AGS Algorithm 272
 - 12.4 There Is No Straightforward Inductive Algorithm
for the AGS Approach 272
 - 12.4.1 Even the Case with Simple (Not Multi) Sets
Is Quite Complicated 272
 - 12.4.2 The Multiset Case 273
 - 12.5 The Arrow Counting Approach 277
 - 12.5.1 Definition and Discussion 277
 - 12.5.2 Comparison of the AGS and the Arrow Counting
Approach 278

13	Equational CTD	283
13.1	Summary	283
13.2	Methodological Orientation	283
13.2.1	Discussion and Examples	284
13.2.2	Theories and Equations	287
13.2.3	Generating <i>B</i> -Theories	290
13.3	Equational Modelling of Contrary-to-Duty Obligations	292
13.3.1	Contrary-to-Duty Obligations	292
13.3.2	Standard Deontic Logic and Its Problems	293
13.3.3	The Equational Approach to CTD	296
13.3.4	Looping CTDs	310
13.3.5	Methodological Discussion	316
13.4	Equational Semantics for General CTD Sets	323
13.5	Proof Theory for CTDs	329
13.6	Comparing with Makinson and Torre's Input Output Logic	338
13.7	Comparing with Governatori and Rotolo's Logic of Violations	342
13.8	Conclusion	344
14	Conclusion	345
	Bibliography	351
	Index	357