

Contents

Part I Introduction

1 From the Tannhäuser Gate to z8_GND_5296: A Day Trip on the Life-Cycle of Information	3
Alfons Josef Schuster	
1.1 Introduction	3
1.2 From Caveman to Spaceman	5
1.3 Digits, Revolutions, and the Information Life-Cycle	7
1.3.1 The Information Life-Cycle	10
1.4 Data, Information, and Knowledge	11
1.4.1 Data	12
1.4.2 Information	13
1.4.3 Knowledge	13
1.5 Fundamental Information Life-Cycle Processes	14
1.5.1 Acquisition and Collection	15
1.5.2 Storage and Classification	16
1.5.3 Analysis and Manipulation	17
1.5.4 Retrieval, Dissemination, Usage, and Maintenance	19
1.6 Information Society	20
1.6.1 Decentralized Information Society	20
1.6.2 A Voice for Information Society	22
1.7 Summary	23
References	23

Part II The World of Large and Small Systems

2 Expanding Beyond the Solar System: Current Observation and Theory	29
Ko Yamada and Satoshi Inaba	
2.1 Introduction	29
2.2 Observation of Extrasolar Planets	30

- 2.2.1 Radial Velocity Survey Detection..... 32
- 2.2.2 Transit Search Detection 33
- 2.2.3 Gravitational Microlensing Detection 34
- 2.2.4 Direct Detection 35
- 2.3 Characteristic of Extrasolar Planets 35
- 2.4 Planet Formation 39
 - 2.4.1 Formation of a Protoplanetary Disk 39
 - 2.4.2 Formation of Protoplanet 40
 - 2.4.3 Formation of Gas Giant Planets..... 41
- 2.5 Data Processing for Extrasolar Planet Research 44
 - 2.5.1 Data Acquisition 44
 - 2.5.2 Data Management 45
 - 2.5.3 Data Analysis 46
- 2.6 Summary..... 47
- References..... 48
- 3 Information in Quantum Theory 51**
 - Andrew Whitaker
 - 3.1 Introduction..... 51
 - 3.2 Quantum Information Theory 52
 - 3.3 Quantum Computation 53
 - 3.4 Quantum Cryptography 56
 - 3.5 Quantum Teleportation..... 58
 - 3.6 Quantum Information 59
 - 3.7 The Universe as a Quantum Computer 62
 - 3.8 Summary..... 63
 - References..... 64

Part III The World of Living Things

- 4 The Potential of Plants and Seeds in DNA-Based Information Storage 69**
 - Karin Fister, Iztok Fister Jr., and Jana Murovec
 - 4.1 Introduction..... 69
 - 4.2 Materials and Methods 71
 - 4.2.1 DNA Basics 72
 - 4.2.2 Coding Program 73
 - 4.2.3 Code DNA Synthesis and Cloning 74
 - 4.2.4 Plant Material 74
 - 4.2.5 Plant Transformation 74
 - 4.2.6 DNA Isolation and PCR Analysis 75
 - 4.2.7 Sanger Sequencing 76
 - 4.3 Results 77
 - 4.3.1 Coding Program 77
 - 4.3.2 Storing Data in *N. Benthamiana* and Reading Data from the Plant 77

4.4	Discussion	78
4.5	Summary	79
	References	80
5	Memory Processing in the Nervous System	83
	Naoyuki Sato	
5.1	Introduction	83
5.2	Physiological Basis of Memory	85
5.2.1	Neuron: The Unit of Information Coding and Processing	85
5.2.2	Synapse: The Principal Component of Memory	86
5.2.3	Neural Oscillations: Dynamics for Cooperation Among Neural Populations	88
5.3	Memory Classification	90
5.3.1	Development: Shaping the Basic Structure of the Nervous System	91
5.3.2	Short-Term and Working Memory	91
5.3.3	Long-Term Memory	92
5.4	The Arrival of Big Data to Neuroscience	93
5.4.1	Brain Structure Data	94
5.4.2	Database for Task-Related Brain Activation	95
5.4.3	Database of Computational Models	95
5.5	Conclusion	96
	References	96

Part IV The World of Intelligent Machines and Finiteness

6	From Computing Machines to Learning Intelligent Machines: Chronological Development of Alan Turing's Thought on Machines	101
	Katsuhiko Sano and Mai Sugimoto	
6.1	Introduction	101
6.1.1	Related Work	102
6.2	How Can We Model Effective Computation by Human Caclulator?	103
6.2.1	The Entscheidungsproblem and Effective or Mechanical Procedure	103
6.2.2	Turing Machine in 1936: Computing Machine	105
6.2.3	Universal Computing Machine	107
6.2.4	Unsolvable Problems in Turing's 1936 Paper	108
6.2.5	How Did Turing Solve the Entscheidungsproblem Negatively?	110
6.3	From the Universal Computing Machine to Practical Computing Machines	112
6.3.1	Turing's Dissertation at Princeton: Oracle Machine	112
6.3.2	Turing and Practical Computing Machines	112

6.4	Three Requirements for Intelligent Behavior of Machines at Lecture to the London Mathematical Society	114
6.5	Learning Process to Organize Intelligent Machinery	116
6.5.1	How to Obtain Machine with Discipline and Initiative ...	117
6.5.2	P-Type Machines	118
6.5.3	The Scope of P-Type Machines and Beyond	121
6.6	How Can We Construct an Intelligent Machine to Pass the Imitation Game?.....	123
6.6.1	The Imitation Game	123
6.6.2	Learning Process for Child Program.....	125
6.7	Conclusion.....	128
	References.....	129
7	Finite Information Agency	131
	Alfons Josef Schuster	
7.1	Introduction	131
7.2	Information Space Scenarios	133
7.2.1	Scenario 1	133
7.2.2	Scenario 2	137
7.2.3	Scenario 3	138
7.3	Mathematical Modeling	140
7.4	Interpretations of Finite Information Spaces	141
7.4.1	The General Value of the Model	141
7.4.2	The Model from an Information Society and Evolutionary Point of View	143
7.4.3	The Model from a Computational Point of View	145
7.5	Summary.....	149
	References.....	149
 Part V The World of Networks, Clouds, and Big Data Processing		
8	Distributed and Connected Information in the Internet	153
	Jürgen Vogel	
8.1	Introduction	153
8.2	Web Data	155
8.2.1	Web Data Format and Web Applications	156
8.2.2	Searching and Finding Data.....	157
8.2.3	Evaluating Information Retrieval Algorithms	159
8.3	Social Data.....	160
8.4	User Data	161
8.5	Text Data.....	163
8.6	Machine Data	165
8.7	Big Data	167
8.8	Linked Data.....	168
8.9	Summary.....	170
	References.....	170

9 Custom Hardware Versus Cloud Computing in Big Data 175
 Gaye Lightbody, Fiona Browne, and Valeriia Haberland

9.1 Introduction 175

9.2 Applications 177

 9.2.1 Genomics and Proteomics 177

 9.2.2 Digital Pathology 178

 9.2.3 Self-Quantification 178

 9.2.4 Surveillance 179

 9.2.5 Internet-of-Things 180

 9.2.6 Finance 181

9.3 Computational Challenges 181

9.4 High-Performance Computing Solutions 182

 9.4.1 Graphics Processing Units (GPU) Computing 182

 9.4.2 Field Programmable Gate Arrays 183

 9.4.3 Cloud Computing Platforms 184

 9.4.4 Deep Learning Libraries 185

9.5 The Role for Custom Hardware 186

 9.5.1 Deep Learning 187

 9.5.2 ASIC Enhanced Cloud Platforms 187

 9.5.3 ASIC Deep Learning Processors 188

9.6 Discussion 188

References 190

Part VI The World of Society and Philosophy

10 Information Overload in a Data-Intensive World 197
 Tibor Koltay

10.1 Introduction 197

10.2 Information Overload 198

 10.2.1 General Characteristics of Information Overload 199

 10.2.2 Information Overload in Business Environments 200

 10.2.3 Information Overload in Everyday Life
 Information Seeking 201

 10.2.4 The Role of Information Technology 202

 10.2.5 Information Overload in the Data-Intensive World 202

10.3 Alleviating the Symptoms of Information Overload 203

 10.3.1 Design and Information Architecture 204

 10.3.2 Interacting with Information 205

10.4 Discussion 212

10.5 Summary 213

References 213

11 Causal/Informational Theories of Mental Content 219
 Fred Adams

11.1 Introduction 219

11.2 Natural vs. Non-natural Meaning 221

11.3 Isomorphism Plus Causation and Conditions of Fidelity 221

11.4 Information-Based Theories 223

11.5 Attack on Wisconsin Semantics 224

 11.5.1 Contra Stampe 225

 11.5.2 Contra Dretske 226

11.6 Dretske’s Response: Indicator Function Account 228

11.7 Fodor’s Asymmetrical Causal Dependency Theory of Meaning... 230

11.8 Conclusion 231

References 232

Index 235