

Randomness Through Computation

Some Answers, More Questions

editor

Hector Zenil

Wolfram Research Inc., USA

 **World Scientific**

NEW JERSEY • LONDON • SINGAPORE • BEIJING • SHANGHAI • HONG KONG • TAIPEI • CHENNAI

Contents

<i>Preface</i>	vii
<i>Acknowledgments</i>	xiii
Part I. Stochastic Randomness and Probabilistic Deliberations	
1. Is Randomness Necessary? <i>R. Graham</i>	3
2. Probability is a Lot of Logic at Once: If You Don't Know Which One to Pick, Take 'em All <i>T. Toffoli</i>	7
3. Statistical Testing of Randomness: New and Old Procedures <i>A. L. Rukhin</i>	33
4. Scatter and Regularity Imply Benford's Law... and More <i>N. Gauvrit & J.-P. Delahaye</i>	53
Part II. Randomness and Computation in Connection to the Physical World	
5. Some Bridging Results and Challenges in Classical, Quantum and Computational Randomness <i>G. Longo, C. Palamidessi & T. Paul</i>	73

6.	Metaphysics, Metamathematics and Metabiology <i>G. Chaitin</i>	93
7.	Uncertainty in Physics and Computation <i>M. A. Stay</i>	105
8.	Indeterminism and Randomness Through Physics <i>K. Svozil</i>	109
9.	The Martin-Löf-Chaitin Thesis: The Identification by Recursion Theory of the Mathematical Notion of Random Sequence <i>J.-P. Delahaye</i>	121
10.	The Road to Intrinsic Randomness <i>S. Wolfram</i>	141
Part III. Algorithmic Inference and Artificial Intelligence		
11.	Algorithmic Probability — Its Discovery — Its Properties and Application to Strong AI <i>R. J. Solomonoff</i>	149
12.	Algorithmic Randomness as Foundation of Inductive Reasoning and Artificial Intelligence <i>M. Hutter</i>	159
13.	Randomness, Occam's Razor, AI, Creativity and Digital Physics <i>J. Schmidhuber</i>	171
Part IV. Randomness, Information and Computability		
14.	Randomness Everywhere: My Path to Algorithmic Information Theory <i>C. S. Calude</i>	179

15.	The Impact of Algorithmic Information Theory on Our Current Views on Complexity, Randomness, Information and Prediction	191
	<i>P. Gács</i>	
16.	Randomness, Computability and Information	197
	<i>J. S. Miller</i>	
17.	Studying Randomness Through Computation	207
	<i>A. Nies</i>	
18.	Computability, Algorithmic Randomness and Complexity	223
	<i>R. G. Downey</i>	
19.	Is Randomness Native to Computer Science? Ten Years After	243
	<i>M. Ferbus-Zanda & S. Grigorieff</i>	
Part V. Computational Complexity, Randomized Algorithms and Applications		
20.	Randomness as Circuit Complexity (and the Connection to Pseudorandomness)	267
	<i>E. Allender</i>	
21.	Randomness: A Tool for Constructing and Analyzing Computer Programs	275
	<i>A. Kučera</i>	
22.	Connecting Randomness to Computation	283
	<i>M. Li</i>	
23.	From Error-correcting Codes to Algorithmic Information Theory	293
	<i>L. Staiger</i>	
24.	Randomness in Algorithms	297
	<i>O. Watanabe</i>	

Part VI. Panel Discussions (Transcriptions)

25. Is the Universe Random?	309
<i>C. S. Calude, J. L. Casti, G. J. Chaitin, P. C. W. Davies, K. Svozil & S. Wolfram</i>	
26. What is Computation? (How) Does Nature Compute?	351
<i>C. S. Calude, G. J. Chaitin, E. Fredkin, A. J. Leggett, R. de Ruyter, T. Toffoli & S. Wolfram</i>	
<i>Author Index</i>	405
<i>Subject Index</i>	411