

Contents

1	Looking at the Nonlinear World	1
1.1	Characteristics of linear systems	2
1.2	Characteristics of nonlinear systems	10
1.3	Intrinsically nonlinear systems	16
1.4	What do we mean by ‘appreciating the world’?	17
1.5	The structure of this book	19
2	Conceptual Analysis	35
2.1	Starting with typical examples—chaos as an example	39
2.2	Dynamical systems	51
2.3	Characterizing chaos	57
2.4	How to quantify ‘history’	64
2.5	How to quantify information	72
2.6	Measure-theoretical dynamical systems	76
2.7	How to quantify chaos	80
2.8	Preparation for characterizing randomness	91
2.9	What is computation?	96
2.10	Turing machine	99
2.11	Characterizing randomness	103
2.12	Understanding the essence of chaos	105
2.13	Is the characterization of randomness satisfactory?	110
2.14	How is ‘complexity’ understood?	111
3	Phenomenology	121
3.1	What is phenomenology?	123
3.2	Phenomenology too universal to be recognized	133
3.3	How to obtain phenomenology—relation to renormalization ..	139
3.4	Two approaches to renormalization	144
3.5	ABC of renormalization	145
3.6	Longtime behavior and renormalization: a simple example ...	160
3.7	Resonance and renormalization	166

3.8	How reliable is the renormalization group result?	173
3.9	Proto-renormalization group approach to system reduction . .	176
3.10	Statistics seen from the renormalization group point of view .	183
4	Modeling	191
4.1	What is a model?	192
4.2	Correspondence between models and reality	195
4.3	Models as tools of description	200
4.4	Models as tools of deduction	206
4.5	Examples of modeling—examples of abduction—	207
4.6	What characterizes good models?	217
4.7	By-products of modeling	223
5	Toward Complexity	235
5.1	Meaning and value	236
5.2	Pasteur process	243
5.3	Fundamental conditions	247
5.4	What do ‘fundamental conditions’ imply?	255
5.5	How can we approach complex systems?	261
5.6	Is there a ‘theory of biological systems’?	264
5.7	How do fundamental conditions evolve?	268
5.8	How do systems complexify?	272
5.9	Integration step and its logical consequence	275
5.10	‘Lessons’ we learn from complex systems	281
Index	293