

Contents

1	Introduction	1
	Bibliography	3
2	Fuzzy Sets	5
2.1	Fuzzy Sets	5
2.1.1	Fuzzy Numbers	5
2.1.2	Alpha-Cuts	7
2.1.3	Inequalities	9
2.1.4	Discrete Fuzzy Sets	9
2.2	Fuzzy Arithmetic	9
2.2.1	Extension Principle	9
2.2.2	Interval Arithmetic	10
2.2.3	Fuzzy Arithmetic	11
2.3	Fuzzy Functions	12
2.3.1	Extension Principle	13
2.3.2	Alpha-Cuts and Interval Arithmetic	13
2.3.3	Differences	14
2.4	Possibility Theory	15
	Bibliography	17
3	Solving Fuzzy Equations	19
3.1	$\overline{A} \overline{X} + \overline{B} = \overline{C}$	19
3.2	New Solutions	22
3.3	Systems of Fuzzy Linear Equations	24
3.4	Applications	33
3.4.1	Fuzzy Linear Equation	33
3.4.2	Fuzzy Quadratic Equation	34
3.4.3	System of Linear Equations	35
3.5	Fuzzy Input-Output Analysis	39
3.5.1	The Open Model	39
3.5.2	Fuzzy Model	41
3.6	Summary and Conclusions	43
	Bibliography	45

4	Fuzzy Mathematics in Finance	47
4.1	Future Value	48
4.2	Present Value	50
4.3	Annuities	53
4.3.1	Future Value	53
4.3.2	Present Value	54
4.4	Portfolio Analysis	55
4.4.1	NPV Method	55
4.4.2	IRR Method	59
4.5	Summary and Conclusions	62
	Bibliography	65
5	Fuzzy Non-Linear Regression	69
5.1	Univariate Non-Linear Fuzzy Regression	70
5.1.1	Testing the EA	71
5.1.2	Application	72
5.2	Multivariate Non-Linear Fuzzy Regression	74
5.2.1	Testing	75
5.2.2	Application	75
5.3	Conclusions and Results	76
	Bibliography	77
6	Operations Research	81
6.1	Fuzzy Linear Programming	81
6.1.1	Maximize \bar{Z}	82
6.1.2	Fuzzy Inequality	85
6.1.3	Evolutionary Algorithm	88
6.1.4	Applications	89
6.1.5	Summary and Conclusions	97
6.2	Fuzzy PERT	98
6.2.1	Job Times Fuzzy Numbers	102
6.2.2	Job Times Discrete Fuzzy Sets	104
6.2.3	Summary	104
6.3	Fuzzy Inventory Control	105
6.3.1	Demand Not Fuzzy	109
6.3.2	Fuzzy Demand	111
6.3.3	Backorders	117
6.3.4	Evolutionary Algorithm	118
6.4	Fuzzy Queuing Theory	118
6.4.1	Service	120
6.4.2	Arrivals	121
6.4.3	Finite or Infinite System Capacity	122
6.4.4	Machine Servicing Problem	124
6.4.5	Fuzzy Queuing Decision Problem	126
6.4.6	Summary and Conclusions	129

6.5	Fuzzy Network Analysis	129
6.5.1	Fuzzy Shortest Route	130
6.5.2	Fuzzy Min-Cost Capacitated Network	132
6.5.3	Evolutionary Algorithm	136
6.5.4	Summary and Conclusions	137
6.6	Summary and Conclusions	137
	Bibliography	139
7	Fuzzy Differential Equations	145
7.1	Fuzzy Initial Conditions	146
7.1.1	Electrical Circuit	150
7.1.2	Vibrating Mass	153
7.1.3	Dynamic Supply and Demand	155
7.2	Other Fuzzy Parameters	158
7.3	Summary and Conclusions	161
	Bibliography	163
8	Fuzzy Difference Equations	165
8.1	Difference Equations	166
8.2	Fuzzy Initial Conditions	167
8.2.1	Classical Solution	167
8.2.2	Extension Principle Solution	169
8.2.3	Interval Arithmetic Solution	172
8.2.4	Summary	174
8.3	Recursive Solutions	175
8.4	Applications	176
8.4.1	National Income	176
8.4.2	Transmission of Information	178
8.4.3	Fuzzy Fibonacci Numbers	179
8.5	Summary and Conclusions	180
	Bibliography	183
9	Fuzzy Partial Differential Equations	185
9.1	Elementary Partial Differential Equations	185
9.2	Classical Solution	187
9.3	Extension Principle Solution	190
9.4	Summary and Conclusions	194
	Bibliography	197
10	Fuzzy Eigenvalues	199
10.1	Fuzzy Eigenvalue Problem	199
10.1.1	Algorithm	203
10.2	Fuzzy Input-Output Analysis	206
10.3	Fuzzy Hierarchical Analysis	209
10.3.1	The λ_{\max} -Method	210

10.3.2	Fuzzy λ_{\max} -Method	212
10.3.3	Fuzzy Geometric Row Mean Method	222
10.4	Summary and Conclusions	224
	Bibliography	227
11	Fuzzy Integral Equations	229
11.1	Resolvent Kernel Method	230
11.1.1	Classical Solution	231
11.1.2	Second Solution Method	235
11.2	Symmetric Kernel Method	237
11.2.1	Classical Solution	237
11.2.2	Second Solution Method	239
11.3	Summary and Conclusions	240
	Bibliography	241
12	Summary and Conclusions	243
12.1	Summary	243
12.1.1	Chapter 3: Solving Fuzzy Equations	243
12.1.2	Chapter 4: The Fuzzy Mathematics in Finance	244
12.1.3	Chapter 5: Fuzzy Non-Linear Regression	244
12.1.4	Chapter 6: Operations Research	245
12.1.5	Chapter 7: Fuzzy Differential Equations	247
12.1.6	Chapter 8: The Fuzzy Difference Equations	248
12.1.7	Chapter 9: Fuzzy Partial Differential Equations	248
12.1.8	Chapter 10: Fuzzy Eigenvalues	249
12.1.9	Chapter 11: Fuzzy Integral Equations	249
12.2	Research Agenda	250
12.2.1	Chapter 3: Solving Fuzzy Equations	250
12.2.2	Chapter 4: The Fuzzy Mathematics of Finance	250
12.2.3	Chapter 5: Fuzzy Non-Linear Regression	250
12.2.4	Chapter 6: Operations Research	250
12.2.5	Chapter 7: Fuzzy Differential Equations	251
12.2.6	Chapter 8: Fuzzy Difference Equations	252
12.2.7	Chapter 9: Fuzzy Partial Differential Equations	252
12.2.8	Chapter 10: Fuzzy Eigenvalues	252
12.2.9	Chapter 11: Fuzzy Integral Equations	252
12.3	Conclusions	252
13	Evolutionary Algorithms	253
13.1	Introduction	253
13.2	General Purpose Algorithm	253
	Bibliography	257
Index		259

CONTENTS

xi

List of Figures

267

List of Tables

271



<http://www.springer.com/978-3-7908-1456-9>

Fuzzy Mathematics in Economics and Engineering

Buckley, J.J.; Eslami, E.; Feuring, Th.

2002, XI, 272 p., Hardcover

ISBN: 978-3-7908-1456-9

A product of Physica-Verlag Heidelberg