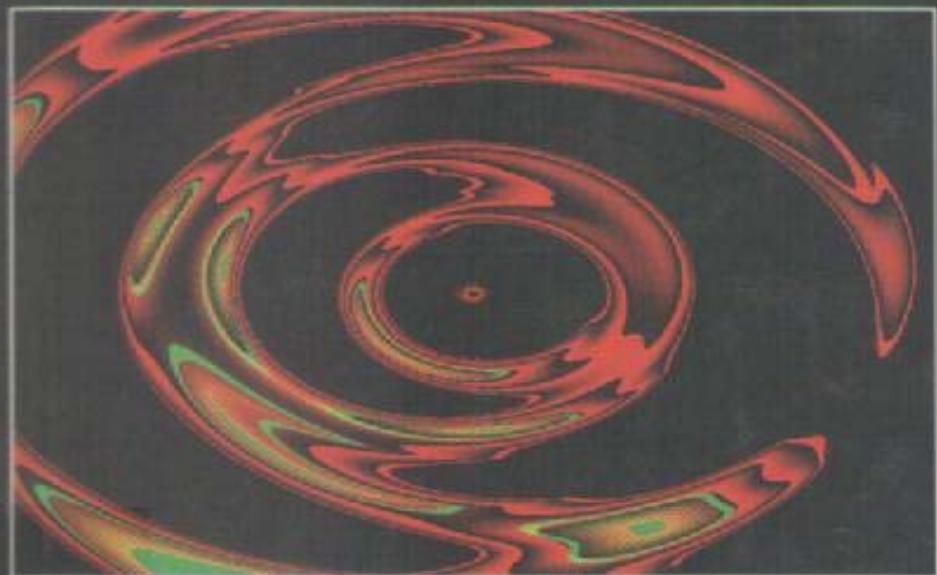


Applied Evolutionary Algorithms in Java



Robert Ghanea-Hercock



CD-ROM
Included

2-005-575-1

2-005-575-1

Robert Ghanea-Hercock

Applied Evolutionary Algorithms in Java

With 57 Illustrations



INCLUDES
CD-ROM



Springer

Contents

Preface	v
---------------	---

1 Introduction to Evolutionary Computing	1
1.1 Evolutionary Computation	1
1.2 History of Evolutionary Computing	2
1.3 Obstacles to Evolutionary Computation	3
1.4 Machine Learning	3
1.5 Problem Domains	4
<i>1.5.1 Search Spaces</i>	4
<i>1.5.2 Optimisation Versus Robustness</i>	6
<i>1.5.3 Expert Systems and AI</i>	6
<i>1.5.4 Fuzzy Logic</i>	7
<i>1.5.5 Bayesian Networks</i>	9
<i>1.5.6 Artificial Neural Networks</i>	10
<i>1.5.7 Feedforward Networks</i>	11
1.6 Applications	12
<i>1.6.1 Problems</i>	13
1.7 Evolution-Based Search	14
<i>1.7.1 Languages for Evolutionary Computing</i>	14
<i>1.7.2 C and C++</i>	14
<i>1.7.3 Pascal and Fortran</i>	15
<i>1.7.4 Visual Basic</i>	15
<i>1.7.5 Java</i>	15
<i>1.7.6 Object-Oriented Design</i>	16
<i>1.7.8 Java and OO Design</i>	16
1.8 Summary	17
<i>Further Reading</i>	18
2 Principles of Natural Evolution	19
2.1 Natural Selection	19
<i>2.1.1 Genes and Chromosomes</i>	19
<i>2.1.2 Biological Genes</i>	20

2.2 DNA Structure.....	20
2.2.1 <i>Transcription – from DNA to RNA</i>	21
2.2.2 <i>Translation – from RNA to Protein</i>	21
2.2.3 <i>Genotype</i>	21
2.2.4 <i>No Lamarckianism!</i>	22
2.2.5 <i>Evolution and Variation</i>	22
2.2.6 <i>Redundancy</i>	22
2.2.7 <i>Self-Maintenance</i>	22
2.2.8 <i>Evolvability</i>	23
2.2.9 <i>Mutation</i>	23
2.2.10 <i>Sexual Recombination</i>	24
2.2.11 <i>Nonselectionist Issues</i>	24
2.2.12 <i>Epigenesis</i>	24
2.2.13 <i>Dynamics and Morphogenesis</i>	25
2.3 Summary	25
<i>Further Reading</i>	26
3 Genetic Algorithms.....	27
3.1 Genetic Algorithms.....	27
3.2 GA Basics.....	27
3.2.1 <i>Fitness and Evaluation Functions</i>	27
3.3 GA Theory.....	30
3.3.1 <i>Deception</i>	31
3.3.2 <i>Messy Genetic Algorithm</i>	31
3.4 GA Operators	32
3.4.1 <i>Mutation</i>	32
3.4.2 <i>Crossover</i>	33
3.4.3 <i>Multipoint Crossover</i>	34
3.4.4 <i>Selection</i>	34
3.4.5 <i>Fitness-Proportionate Selection</i>	36
3.4.6 <i>Disadvantages of Fitness-Proportionate Selection</i>	37
3.4.7 <i>Rank Selection</i>	37
3.4.8 <i>Tournament Selection</i>	38
3.4.9 <i>Scaling Methods</i>	39
3.5 Pros and Cons of Genetic Algorithms	39
3.6 Selecting GA methods.....	40
3.6.1 <i>Encoding Choice</i>	40
3.6.2 <i>Operator Choice</i>	42
3.6.3 <i>Elitism</i>	42
3.7 Example GA Application	42
3.8 Summary	45
<i>Further Reading</i>	46

4 Genetic Programming.....	47
4.1 Genetic Programming.....	47
4.2 Introduction to Genetic Programming.....	47
4.2.1 Variable-length and Tree-Based Representations.....	49
4.2.2 GP Terminal Set	49
4.2.3 GP Function Set	49
4.2.4 Function Closure	50
4.2.5 Tree Structure Processing	50
4.2.6 Linear Structure Encoding	50
4.2.7 Graph Structure Encoding.....	51
4.2.8 GP Initialisation	51
4.3 GP Operators	52
4.3.1 GP Crossover	52
4.3.2 Mutation	52
4.3.3 Selection Operators in GP.....	52
4.3.4 Controlling Genome Growth	53
4.4 Genetic Programming Implementation.....	54
4.4.1 Advances in GP — Automatically Defined Functions	54
4.5 Summary	55
Further Reading	56
5 Engineering Examples Using Genetic Algorithms.....	57
5.1 Introduction	57
5.2 Digital Image Processing.....	57
5.3 Basics of Image Processing.....	58
5.3.1 Convolution	58
5.3.2 Lookup Tables	59
5.4 Java and Image Processing	60
5.4.1 Example Application — VEGA	61
5.4.2 Operator Search Space.....	61
5.4.3 Implementation	61
5.5 Spectrographic Chromosome Representation.....	67
5.6 Results	68
5.6.1 GA Format.....	68
5.7 Summary - Evolved Image Processing.....	70
5.8 Mobile Robot Control.....	71
5.8.1 Artificial Intelligence and Mobile Robots	72
5.8.2 Planning	72
5.8.3 Static Worlds	73
5.8.4 Reactive and Bottom-up Control	74
5.8.5 Advantages of Reactive Control	76
5.8.6 Alternative Strategies	76
5.9 Behaviour Management.....	77

<i>C.2.1 Fuzzy Operators</i>	171
<i>C.2.2 Linguistic Variables</i>	171
<i>C.2.3 Fuzzy IF</i>	172
<i>C.2.4 Fuzzy Associative Memories</i>	173
<i>C.2.5 Fuzzy Control Systems</i>	174
<i>C.2.6 Defuzzification</i>	175
<i>C.2.7 Fuzzy Applications</i>	178
<i>C.3 Limitations of Fuzzy Control</i>	178
<i>C.3.1 Advantages of Fuzzy Systems</i>	179
<i>C.4 Summary</i>	180
<i>Further Reading</i>	180
Appendix D	181
Introduction	181
System Overview.....	181
Use and License.....	181
Programming Language and Run-Time Environment.....	182
Top-Level Directory Files and Hierarchy.....	182
Units of Measure	183
The Client-Server Architecture	183
<i>Network/Local Connections Versus Dynamically Loaded Clients</i>	184
<i>Why a Client-Server Architecture?</i>	185
<i>Client-Server Communications</i>	185
<i>Network and Local Connection Issues</i>	186
<i>Communication via Events and Requests</i>	187
<i>Keeping the RPI Protocol Language-Independent</i>	188
Configuration Elements and Properties Files	188
<i>The "port" and "hostName" Properties</i>	189
<i>Overriding Properties</i>	189
<i>Loading RsProperties Files as a Resource</i>	190
The Server	191
<i>Server Properties Files</i>	191
Accepting Clients.....	191
The Scheduler.....	192
The Floor Plan.....	194
<i>Syntax and Semantics</i>	194
Building a Virtual Robot.....	196
Introduction.....	196
Thinking About Client Design	196
The Demonstration Clients.....	196
Life Cycle of the Demonstration Clients	197
How ClnMain Extends RsClient and Implements RsRunnable.....	199
<i>The RsRunnable Interface</i>	200

<i>Building RsRunnable and RsClient into ClnMain.</i>	201
<i>DemoMain Implements RsRunnable, But Does Not Extend RsClient.</i>	202
<i>The Execution of ClnMain</i>	202
<i>Uploading the Body Plan</i>	204
<i>Registering Event Handlers</i>	204
<i>Running the Event Loop</i>	205
<i>How the Demo Clients Work</i>	205
Physical Layout of ClientZero	207
The RsBody and RsBodyPart Classes	207
<i>RsBodyShape</i>	209
<i>RsWheelSystem</i>	210
<i>The Sensor Classes</i>	212
<i>RxBodyTargetSensor</i>	213
<i>RsBodyContactSensor</i>	213
Events and Requests	214
Index	216