

Intelligent Optimisation Techniques

Genetic Algorithms,
Tabu Search,
Simulated Annealing
and Neural Networks

D.T. Pham and D. Karaboga



Springer

Contents

1 Introduction	1
1.1 Genetic Algorithms	1
1.1.1 Background	1
1.1.2 Representation	2
1.1.3 Creation of Initial Population	3
1.1.4 Genetic Operators	3
1.1.5 Control Parameters	7
1.1.6 Fitness Evaluation Function	7
1.2 Tabu Search	8
1.2.1 Background	8
1.2.2 Strategies	8
1.3 Simulated Annealing	11
1.3.1 Background	11
1.3.2 Basic Elements	13
1.4 Neural Networks	15
1.4.1 Basic Unit	15
1.4.2 Structural Categorisation	18
1.4.3 Learning Algorithm Categorisation	19
1.4.4 Optimisation Algorithms	20
1.4.5 Example Neural Networks	22
1.5 Performance of Different Optimisation Techniques on Benchmark Test Functions	27
1.5.1 Genetic Algorithm Used	28
1.5.2 Tabu Search Algorithm Used	30
1.5.3 Simulated Annealing Algorithm Used	31
1.5.4 Neural Network Used	31
1.5.5 Results	33
1.6 Performance of Different Optimisation Techniques on Travelling Salesman Problem	44
1.6.1 Genetic Algorithm Used	44
1.6.2 Tabu Search Algorithm Used	45
1.6.3 Simulated Annealing Algorithm Used	45

1.6.4 Neural Network Used	46
1.6.5 Results	47
1.7 Summary	47
References	47

2 Genetic Algorithms

2.1 New Models	51
2.1.1 Hybrid Genetic Algorithm	51
2.1.2 Cross-Breeding in Genetic Optimisation	62
2.1.3 Genetic Algorithm with the Ability to Increase the Number of Alternative Solutions	63
2.1.4 Genetic Algorithms with Variable Mutation Rates	69
2.2 Engineering Applications	78
2.2.1 Design of Static Fuzzy Logic Controllers	78
2.2.2 Training Recurrent Neural Networks	97
2.2.3 Adaptive Fuzzy Logic Controller Design	111
2.2.4 Preliminary Gearbox Design	126
2.2.5 Ergonomic Workplace Layout Design	131
2.3 Summary	140
References	141

3 Tabu Search

3.1 Optimising the Effective Side-Length Expression for the Resonant Frequency of a Triangular Microstrip Antenna	149
3.1.1 Formulation	151
3.1.2 Results and Discussion	155
3.2 Obtaining a Simple Formula for the Radiation Efficiency of a Resonant Rectangular Microstrip Antenna	157
3.2.1 Radiation Efficiency of Rectangular Microstrip Antennas	159
3.2.2 Application of Tabu Search to the Problem	160
3.2.3 Simulation Results and Discussion	164
3.3 Training Recurrent Neural Networks for System Identification	165
3.3.1 Parallel Tabu Search	165
3.3.2 Crossover Operator	166
3.3.3 Training the Elman Network	167
3.3.4 Simulation Results and Discussion	168
3.4 Designing Digital Finite-Impulse-Response Filters	173
3.4.1 FIR Filter Design Problem	173
3.4.2 Solution by Tabu Search	174
3.4.3 Simulation Results	175
3.5 Tuning PID Controller Parameters	177

3.5.1 Application of Tabu Search to the Problem	178
3.5.2 Simulation Results	179
3.6 Summary	181
References	182
 4 Simulated Annealing	 187
4.1 Optimal Alignment of Laser Chip and Optical Fibre	187
4.1.1 Background	187
4.1.2 Experimental Setup	188
4.1.3 Initial Results	192
4.1.4 Modification of Generation Mechanism	193
4.1.5 Modification of Cooling Schedule	193
4.1.6 Starting Point	194
4.1.7 Final Modifications to the Algorithm	195
4.1.8 Results	197
4.2 Inspection Stations Allocation and Sequencing	197
4.2.1 Background	198
4.2.2 Transfer Functions Model	200
4.2.3 Problem Description	202
4.2.4 Application of Simulated Annealing	204
4.2.5 Experimentation and Results	206
4.3 Economic Lot-Size Production	209
4.3.1 Economic Lot-Size Production Model	210
4.3.2 Implementation to Economic Lot-Size Production	213
4.4 Summary	217
References	217
 5 Neural Networks	 219
5.1 VLSI Placement using MHSO Networks	219
5.1.1 Placement System Based on Mapping Self-Organising Network	221
5.1.2 Hierarchical Neural Network for Macro Cell Placement	225
5.1.3 MHSO2 Experiments	228
5.2 Satellite Broadcast Scheduling using a Hopfield Network	230
5.2.1 Problem Definition	231
5.2.2 Neural-Network Approach	233
5.2.3 Simulation Results	235
5.3 Summary	238
References	238

Appendix 1 Classical Optimisation.....	241
A1.1 Basic Definitions.....	241
A1.2 Classification of Problems	243
A1.3 Classification of Optimisation Techniques.....	244
References.....	247
 Appendix 2 Fuzzy Logic Control.....	 249
A2.1 Fuzzy Sets	249
A2.1.1 Fuzzy Set Theory	249
A2.1.2 Basic Operations on Fuzzy Sets	250
A2.2 Fuzzy Relations.....	253
A2.3 Compositional Rule of Inference	254
A2.4 Basic Structure of a Fuzzy Logic Controller.....	255
A2.5 Studies in Fuzzy Logic Control.....	258
References.....	259
 Appendix 3 Genetic Algorithm Program	 263
 Appendix 4 Tabu Search Program	 271
 Appendix 5 Simulated Annealing Program	 279
 Appendix 6 Neural Network Programs	 285
 Author Index	 295
 Subject Index.....	 299