

Contents

- 1 Introduction** 1
 - 1.1 Bio-inspired Optimization Methods 1
 - 1.2 Topics Organization 4

- 2 Evolutionary Computation** 5
 - 2.1 Introduction 5
 - 2.1.1 Evolutionary Computation Between Artificial Intelligence and Natural Evolution 5
 - 2.1.2 The Contribution of Genetics 8
 - 2.2 Evolutionary Computation Methods 10
 - 2.2.1 Essential Properties 10
 - 2.2.2 Evolutionary Programming 14
 - 2.2.3 Evolution Strategies 16
 - 2.2.4 Genetic Algorithms 18
 - 2.2.5 Estimation of Distribution Algorithms 20
 - 2.2.6 Differential Evolution 23
 - 2.2.7 Evolutionary Behavior Algorithms 25
 - 2.2.8 A Simple Example of Evolutionary Computation 27
 - 2.3 Properties of Genetic Algorithms 36
 - 2.3.1 Genetic Algorithms as a Paradigm of Evolutionary Computation 36
 - 2.3.2 Evolution of Genetic Algorithms 41
 - 2.3.3 Convergence of Genetic Algorithms 44
 - 2.3.4 Issues in the Implementation of Genetic Algorithms 51
 - 2.3.5 Genetic Algorithms and Random Sampling from a Probability Distribution 56

- 3 Evolving Regression Models** 63
 - 3.1 Introduction 63
 - 3.2 Identification 64
 - 3.2.1 Linear Regression 64
 - 3.2.2 Generalized Linear Models 67
 - 3.2.3 Principal Component Analysis 68

3.3	Parameter Estimation	69
3.3.1	Regression Models	69
3.3.2	The Logistic Regression Model	70
3.4	Independent Component Analysis	74
3.4.1	ICA algorithms	76
3.4.2	Simple GAs for ICA	77
3.4.3	GAs for Nonlinear ICA	83
4	Time Series Linear and Nonlinear Models	85
4.1	Models of Time Series	86
4.2	Autoregressive Moving Average Models	88
4.2.1	Identification of ARMA Models by Genetic Algorithms	91
4.2.2	More General Models	95
4.3	Nonlinear Models	97
4.3.1	Threshold AR and Double Threshold GARCH Models	97
4.3.2	Exponential Models	100
4.3.3	Piecewise Linear Models	103
4.3.4	Bilinear Models	114
4.3.5	Real Data Applications	116
4.3.6	Artificial Neural Networks	118
5	Design of Experiments	125
5.1	Introduction	125
5.2	Experiments and Design of Experiments	126
5.2.1	Randomization, Replication and Blocking	128
5.2.2	Factorial Designs and Response Surface Methodology	129
5.3	The Evolutionary Design of Experiments	132
5.3.1	High-Dimensionality Search Space	132
5.3.2	The Evolutionary Approach to Design Experiments	133
5.3.3	The Genetic Algorithm Design (GA-Design)	135
5.4	The Evolutionary Model-Based Experimental Design: The Statistical Models in the Evolution	144
5.4.1	The Evolutionary Neural Network Design (ENN-Design)	144
5.4.2	The Model Based Genetic Algorithm Design (MGA-Design)	147
5.4.3	The Evolutionary Bayesian Network Design (EBN-Design)	152
6	Outliers	159
6.1	Outliers in Independent Data	159
6.1.1	Exploratory Data Analysis for Multiple Outliers Detection	160
6.1.2	Genetic Algorithms for Detecting Outliers in an i.i.d. Data Set	162
6.2	Outliers in Time Series	167
6.2.1	Univariate ARIMA Models	169
6.2.2	Multivariate Time Series Outlier Models	181

- 6.3 Genetic Algorithms for Multiple Outlier Detection 184
 - 6.3.1 Detecting Multiple Outliers in Univariate Time Series 186
 - 6.3.2 Genetic Algorithms for Detecting Multiple Outliers
in Multivariate Time Series 187
 - 6.3.3 An Example of Application to Real Data 191
- 7 Cluster Analysis 199**
 - 7.1 The Partitioning Problem 199
 - 7.1.1 Classification 200
 - 7.1.2 Algorithms for Clustering Data 204
 - 7.1.3 Indexes of Cluster Validity 212
 - 7.2 Genetic Clustering Algorithms 219
 - 7.2.1 A Genetic Divisive Algorithm 219
 - 7.2.2 Quick Partition Genetic Algorithms 221
 - 7.2.3 Centroid Evolution Algorithms 227
 - 7.2.4 The Grouping Genetic Algorithm 230
 - 7.2.5 Genetic Clustering of Large Data Sets 233
 - 7.3 Fuzzy Partition 234
 - 7.3.1 The Fuzzy c-Means Algorithm 234
 - 7.3.2 Genetic Fuzzy Partition Algorithms 236
 - 7.4 Multivariate Mixture Models Estimation by Evolutionary
Computing 239
 - 7.4.1 Genetic Multivariate Mixture Model Estimates 240
 - 7.4.2 Hybrid Genetic Algorithms and the EM Algorithm 244
 - 7.4.3 Multivariate Mixture Model Estimates with Unknown
Number of Mixtures 246
 - 7.5 Genetic Algorithms in Classification and Regression Trees Models .. 248
 - 7.6 Clusters of Time Series and Directional Data 248
 - 7.6.1 GAs-Based Methods for Clustering Time Series Data 249
 - 7.6.2 GAs-Based Methods for Clustering Directional Data 254
 - 7.7 Multiobjective Genetic Clustering 258
 - 7.7.1 Pareto Optimality 258
 - 7.7.2 Multiobjective Genetic Clustering Outline 259
- References 261**
- Index 273**