
Contents

1	Introduction	1
2	Global optimization problems	7
2.1	Definitions of global optimization problems	7
2.2	General schema of a stochastic search	13
2.3	Basic features of stochastic algorithms of global optimization ..	19
2.4	Genetic algorithms in action – solution of inverse problems in the mechanics of continua	21
3	Basic models of genetic computations	31
3.1	Encoding and inverse encoding	31
3.1.1	Binary affine encoding	34
3.1.2	Gray encoding	37
3.1.3	Phenotypic encoding	38
3.2	Objective and fitness	38
3.3	The individual and population models	39
3.4	Selection	40
3.4.1	Proportional (roulette) selection	41
3.4.2	Tournament selection	42
3.4.3	Elitist selection	42
3.4.4	Rank selection	42
3.5	Binary genetic operations	43
3.5.1	Multi-point mutation	44
3.5.2	Binary crossover	44
3.5.3	Features of binary genetic operations, mixing	46
3.6	Definition of the Simple Genetic Algorithm (SGA)	47
3.7	Phenotypic genetic operations	48
3.7.1	Phenotypic mutation	48
3.7.2	Phenotypic crossover	49
3.7.3	Phenotypic operations in constrained domains	50

3.8	Schemes for creating a new generation	51
3.9	μ, λ – taxonomy of single- and multi-deme strategies	52
4	Asymptotic behavior of the artificial genetic systems	55
4.1	Markov theory of genetic algorithms	55
4.1.1	Markov chains in genetic algorithm asymptotic analysis	57
4.1.2	Markov theory of the Simple Genetic Algorithm	61
4.1.3	The results of the Markov theory for Evolutionary Algorithm	87
4.2	Asymptotic results for very small populations	96
4.2.1	The rate of convergence of the single individual population with hard succession	96
4.2.2	The dynamics of double individual populations with proportional selection	98
4.3	The increment of the schemata cardinality in the single evolution epoch	105
4.4	Summary of practicals coming from asymptotic theory	111
5	Adaptation in genetic search	115
5.1	Adaptation and self-adaptation in genetic search	115
5.2	The taxonomy of adaptive genetic strategies	117
5.3	Single- and twin-population strategies (α)	122
5.3.1	Adaptation of genetic operation parameters ($\alpha.1$)	122
5.3.2	Strategies with a variable life time of individuals ($\alpha.2$)	127
5.3.3	Selection of the operation from the operation set ($\alpha.3$)	130
5.3.4	Introducing local optimization methods to the evolution ($\alpha.4$)	133
5.3.5	Fitness modification ($\alpha.5$)	135
5.3.6	Additional replacement of individuals ($\alpha.6$)	139
5.3.7	Speciation ($\alpha.7$)	141
5.3.8	Variable accuracy searches ($\alpha.8$)	142
5.4	Multi-deme strategies (β)	144
5.4.1	Metaevolution ($\beta.1$)	145
5.4.2	Island models ($\beta.2$)	146
5.4.3	Hierarchic Genetic Strategies ($\beta.3$)	147
5.4.4	Inductive Genetic Programming (iGP) ($\beta.4$)	151
6	Two-phase stochastic global optimization strategies	153
6.1	Overview of two-phase stochastic global strategies	153
6.1.1	Global phase	153
6.1.2	Global phase - why stochastic methods?	154
6.1.3	Local phase	155
6.1.4	Pure Random Search (PRS), Single-Start, Multistart	156
6.1.5	Properties of PRS, Single-Start and Multistart	157
6.1.6	Clustering methods in continuous global optimization	158

6.1.7	Analysis of the reduction phase	160
6.1.8	Density Clustering	162
6.1.9	Single Linkage	166
6.1.10	Mode Analysis	168
6.1.11	Multi Level Single Linkage and Multi Level Mode Analysis	170
6.1.12	Topographic methods (TGO, TMSL)	173
6.2	Stopping Rules	174
6.2.1	Non-sequential rules	176
6.2.2	Sequential rules - optimal and suboptimal Bayesian stopping rules	177
6.2.3	Stopping rules that use values of the objective function	179
6.3	Two-phase genetic methods	179
6.3.1	The idea of Clustered Genetic Search (CGS)	179
6.3.2	Description of the algorithm	181
6.3.3	Stopping rules and asymptotic properties	183
6.3.4	Illustration of performance of Clustered Genetic Search	185
7	Summary and perspectives of genetic algorithms in continuous global optimization	199
	References	207
	Index	219