

Contents

1. Introduction	1
2. Bounded Rationality and Artificial Intelligence	7
2.1 Bounded Rationality in Economics	7
2.2 Artificially Intelligent Agents in Economic Systems	11
2.3 Learning Techniques of Artificially Intelligent Agents	13
2.3.1 Genetic Algorithms and Related Techniques	13
2.3.2 Classifier Systems	14
2.3.3 Neural Networks	17
2.3.4 Cellular Automata	21
2.4 Some Applications of CI Methods in Economic Systems	26
2.4.1 Bidding Strategies in Auctions	26
2.4.2 The Iterated Prisoner's Dilemma	27
2.4.3 Goods Markets	31
2.4.4 Financial Markets	33
2.4.5 Evolving Market Structures	34
2.4.6 Further Simple Economic Models	36
2.5 Potentiality and Problems of CI Techniques in Economics ...	37
3. Genetic Algorithms	41
3.1 What are Genetic Algorithms?	41
3.2 The Structure of Genetic Algorithms	42
3.3 Genetic Operators	43
3.3.1 Selection	43
3.3.2 Crossover	45
3.3.3 Mutation	46
3.3.4 Other Operators	46
3.3.5 An Example	47
3.4 Genetic Algorithms with a Non-Standard Structure	48
3.5 Some Analytical Approaches to Model Genetic Algorithms ...	49
3.5.1 The Schema Theorem	50
3.5.2 The Quantitative Genetics Approach	52
3.5.3 Markov Chain Models	55
3.6 Do Genetic Algorithms Describe Adaptive Learning?	61

3.6.1	Genetic Algorithms and Empirical Evidence	61
3.6.2	Economic Interpretation of the Algorithm	65
4.	Genetic Algorithms with a State Dependent Fitness Function	71
4.1	State Dependency in Economic Systems	71
4.2	A Markov Model for Systems with a State Dependent Fitness Function	72
4.3	The Difference Equations Describing the GA	77
4.4	Deviation from the Markov Process	78
4.5	A Numerical Example	82
4.6	Stability of the Uniform States	83
4.7	Two-Population Models	92
5.	Genetic Learning in Evolutionary Games	97
5.1	Equilibria and Evolutionary Stability	97
5.2	Learning in Evolutionary Games	98
5.3	Learning by a Simple Genetic Algorithm	101
5.3.1	Rock-Scissors-Paper Games	103
5.3.2	A GA Deceptive Game	107
5.3.3	Learning in Non Deceptive Games	111
5.4	Two-Population Contests	114
6.	Simulations with Genetic Algorithms in Economic Systems	121
6.1	A Model of a Competitive Market	121
6.1.1	Pure Quantity Decision	124
6.1.2	Exit and Entry Decisions	127
6.2	An Overlapping Generations Model with Fiat Money	132
6.2.1	Learning of Cyclical Equilibria	136
6.2.2	Learning of Sunspot Equilibria	140
6.3	A Sealed Bid Double Auction Market	143
6.3.1	Constant Cost and Utility Values	143
6.3.2	Stochastic Cost and Utility Values	155
7.	Stability and Encoding	161
7.1	The Cobweb Example Revisited	161
7.2	Impact of a Change in Encoding and Scaling	165
7.3	A Method for Finding Economic Equilibria	167
8.	Conclusions	169
A.	Basic Definitions and Results Used	171
A.1	Time Homogeneous Markov Chains	171
A.2	Nonlinear Difference Equations and Stability	173

B. Calculation of the Equilibria of the Evolutionary Games in Chapter 5	175
B.1 Rock-Scissor-Paper Games	175
B.2 The GA Deceptive Game GAD	177
B.3 The Games G1 and G2	178
C. Proof of Proposition 6.3.1	181
References	183
List of Figures	193
List of Tables	197
Index	199