

# Contents

1. INTRODUCTION	1
Equilibria and transitions	1
Sketch of the argument	2
2. EXPECTATIONS AND BEHAVIOR	6
Rational expectations	6
Rational expectations (static)	7
Rational expectations (dynamic)	8
A model of money and prices	10
Another indeterminacy	13
Computation and 'stability' of equilibrium	16
Static stability and 'adaptive expectations'	16
Computation of dynamic equilibrium	19
Bounded rationality	21
Behavioral aspects of rational expectations	21
Artificial agents who act like econometricians	21
Practice of economics	22
Artificial intelligence	23
Questions and payoffs	24
Equilibrium selection	25
New sources of dynamics	25
Analyses of 'regime changes'	26
Retreating from rational expectations	28
New optimization and estimation methods	33
Plan of the book	34

3. DATA STRUCTURES	35
Statistics and bounded rationality	35
Representation and estimation	35
Two versions of the linear regression model	36
Population version	36
The sample version	37
Vector autoregressions	38
Estimation of vector autoregressions	39
Stochastic approximation	39
Recursive least squares	41
Least squares as stochastic Newton procedures	42
Nonlinear least squares	42
Classification	43
Classification with known moments	43
Estimated parameters	45
Principal components analysis	46
Population theory	46
Data reduction	47
Estimation	47
Factor analysis	47
Overfitting and choice of parameterization	49
Parameterizing vector autoregressions	50
Statistics for bounded rationality	52
4. NETWORKS AND ARTIFICIAL INTELLIGENCE	54
The perceptron	54
The perceptron as classifier	55
Perceptron training	56
Perceptrons and discriminant analysis	57
Feedforward neural networks with hidden units	57
Recurrent networks	60
Associative memory	61
Autoassociation	61

Correlated patterns	65
Heterassociation	66
Memorized patterns as energy minimizers	66
Stochastic networks	67
Combinatorial optimization problems	68
Mean field theory	70
Shadows of things to come	73
Local and global methods	73
The genetic algorithm	74
Classifier systems	77
The brain as a 'competitive economy'	77
A two armed bandit	79
Design decisions	80
Generality versus discrimination	80
Summary	81
5. ADAPTATION IN ARTIFICIAL ECONOMIES	82
A model of Bray	83
Irrationality of expectations	86
Heterogeneity of expectations and size of the state	88
An economy with Markov deficits	89
Stationary rational expectations equilibrium	90
A learning version	93
Some experiments	95
Parametric and non-parametric adaptation	99
Learning the hard way	101
Learning via model formation	102
Approximate equilibria	103
Method of parameterized expectations	105
Learning and equilibrium computation	106
Recursive kernel density estimation	106
Learning in a model of the exchange rate	107
Exchange rate initial-condition dependence	112

The no-trade theorem	113
The environment	114
Prices fully revealing with no trade	115
Computation of the equilibrium	116
Tampering with the no-trade theorem	118
Some experiments	118
Sustaining volume with a constant gain	119
Learning with an infinite horizon	122
Investment under uncertainty	123
Rational expectations equilibrium as a fixed point	124
Least squares learning	125
Convergence theorems	127
An associated ordinary differential equation	129
Propositions	130
Conclusions	132
6. EXPERIMENTS	135
Interpreting experiments	135
A model of inflation	135
The environment	136
Rational expectations solution	136
The least squares dynamics	138
Marimon and Sunder's experiment	139
Experimental results	140
An example in the spirit of Brock	142
Exchange rate experiments	146
The experiment	146
Exchange rate paths	147
A genetic algorithm economy	148