

CONTENTS

1 Non-Cooperative Games	1
1.1 The battle of the sexes	3
1.1.1 Extensive form: Ladies first	3
1.1.2 Normal form: Bimatrix games	5
1.1.3 Mixed strategies	7
1.2 Rationality	10
1.3 The shape of things to come	13
1.3.1 A spectrum auction	13
1.3.2 Attack and defense	17
1.3.3 Customs and smugglers	19
1.4 Nash equilibrium	23
1.4.1 Games in extensive form	23
1.4.2 Normal form and mixed strategies	25
1.4.3 Dominance	26
1.4.4 More definitions	27
1.4.5 An existence theorem	34
1.5 Exercises	38
2 Linear Complementarity	43
2.1 Solving bimatrix games	43
2.1.1 An equivalent representation of equilibrium	45
2.1.2 An equivalence theorem	47
2.1.3 Enumerating the equilibria	49
2.1.4 Degeneracy and a <i>Mathematica</i> program	51
2.1.5 Symbolic solutions and <code>NashEquilibria</code>	55
2.2 Examples	57
2.2.1 Todd's game	57
2.2.2 Von Stengel's game	59
2.2.3 Winkels' game	60
2.3 Exercises	61
3 Zero-Sum Games	65
3.1 Matrix games	65
3.1.1 Maxmin strategies	66
3.1.2 Solving matrix games	68

3.1.3	Five Finger Morra	70
3.2	Linear programming	72
3.2.1	Duality	74
3.2.2	Simplex	81
3.3	Strategy domination	93
3.4	Simplified poker	102
3.5	Exercises	108
4	Degenerate Games	111
4.1	Linear complementarity revisited	111
4.2	Extreme equilibria	113
4.3	Vertex enumeration	119
4.4	Maximal Nash subsets	125
4.5	Exercises	129
5	Inspection Games	131
5.1	Controlling several locations	131
5.1.1	Solution with <i>Mathematica</i>	134
5.1.2	Formalities	138
5.1.3	Legal behavior	139
5.2	Periodic inspections	140
5.2.1	Solution with <i>Mathematica</i>	143
5.2.2	Legal behavior	151
5.3	Playing for time	151
5.3.1	Discrete solutions	152
5.3.2	Solutions on the unit square	154
5.4	Detection probability	158
5.5	A final remark	162
5.6	Exercises	163
6	Evolutionary Games	165
6.1	Symmetric bimatrix games	166
6.2	Evolutionary stability	168
6.2.1	Hawks and doves	169
6.2.2	Childsplay	173
6.2.3	Negative definiteness and eigenvalues	174
6.2.4	Haigh's criterion and an algorithm	176
6.2.5	Bullies and retaliators	180
6.2.6	Attrition or dove meets dove	183
6.2.7	Asymmetric conflicts	184
6.3	Behavior dynamics	186
6.3.1	Dynamical stability	186
6.3.2	An ESS becomes a limit cycle	192
6.4	Exercises	196

7 Games in Extensive Form	199
7.1 Games of perfect information	199
7.1.1 Backward induction	200
7.1.2 Minimax and alpha-beta pruning	203
7.1.3 Othello	207
7.2 Games of imperfect information	210
7.2.1 Subgame perfection	211
7.2.2 Cooperation	213
7.2.3 Behavior strategies, sequences and perfect recall	216
7.3 Perfect equilibrium	220
7.3.1 To err is human	220
7.3.2 Perfection in context	226
7.4 A sequential inspection game	231
7.5 Exercises	241
A Lemke and Howson	245
A.1 Complementary pivoting	245
A.2 Existence, degeneracy and a <i>Mathematica</i> program	251
B GameTheory‘Bimatrix’	255
B.1 Installation	255
B.2 Functions	255
B.3 Symbolic solutions	257
C Solutions to the Exercises	259
C.1 Non-Cooperative Games	259
C.2 Linear Complementarity	268
C.3 Zero-Sum Games	275
C.4 Degenerate Games	283
C.5 Inspection Games	289
C.6 Evolutionary Games	297
C.7 Games in Extensive Form	307
Mathematical Notation	319
Bibliography	321
Index	325