

# Contents

<i>Preface</i>	<i>page ix</i>
<b>1 Introduction</b>	<b>1</b>
1.1 Normative and descriptive decision theory	3
1.2 Rational and right decisions	4
1.3 Risk, ignorance and uncertainty	5
1.4 Social choice theory and game theory	8
1.5 A very brief history of decision theory	10
<b>2 The decision matrix</b>	<b>17</b>
2.1 States	19
2.2 Outcomes	22
2.3 Acts	27
2.4 Rival formalisations	30
<b>3 Decisions under ignorance</b>	<b>40</b>
3.1 Dominance	41
3.2 Maximin and leximin	43
3.3 Maximax and the optimism–pessimism rule	46
3.4 Minimax regret	49
3.5 The principle of insufficient reason	53
3.6 Randomised acts	56
<b>4 Decisions under risk</b>	<b>64</b>
4.1 Maximising what?	65
4.2 Why is it rational to maximise expected utility?	71
4.3 The axiomatic approach	73
4.4 Allais’ paradox	78
4.5 Ellsberg’s paradox	81
4.6 The St Petersburg paradox	83
4.7 The two-envelope paradox	86

<b>5</b>	<b>Utility</b>	<b>91</b>
5.1	How to construct an ordinal scale	91
5.2	von Neumann and Morgenstern's interval scale	94
5.3	Can utility be measured on a ratio scale?	106
5.4	Can we define utility without being able to measure it?	110
<b>6</b>	<b>The mathematics of probability</b>	<b>117</b>
6.1	The probability calculus	118
6.2	Conditional probability	123
6.3	Bayes' theorem	125
6.4	The problem of unknown priors	127
<b>7</b>	<b>The philosophy of probability</b>	<b>133</b>
7.1	The classical interpretation	134
7.2	The frequency interpretation	136
7.3	The propensity interpretation	139
7.4	Logical and epistemic interpretations	141
7.5	Subjective probability	143
<b>8</b>	<b>Why should we accept the preference axioms?</b>	<b>164</b>
8.1	Must a rational preference be transitive?	165
8.2	Must a rational preference be complete?	169
8.3	The multi-attribute approach	172
8.4	Must a rational preference satisfy the independence axiom?	176
8.5	Risk aversion	179
<b>9</b>	<b>Causal vs. evidential decision theory</b>	<b>187</b>
9.1	Newcomb's problem	187
9.2	Causal decision theory	190
9.3	Evidential decision theory	192
<b>10</b>	<b>Bayesian vs. non-Bayesian decision theory</b>	<b>200</b>
10.1	What is Bayesianism?	200
10.2	Arguments for and against Bayesianism	204
10.3	Non-Bayesian approaches	208
<b>11</b>	<b>Game theory I: Basic concepts and zero-sum games</b>	<b>212</b>
11.1	The prisoner's dilemma	214
11.2	A taxonomy of games	220
11.3	Common knowledge and dominance reasoning	224

11.4	Two-person zero-sum games	229
11.5	Mixed strategies and the minimax theorem	232
12	Game theory II: Nonzero-sum and cooperative games	240
12.1	The Nash equilibrium	240
12.2	The battle of the sexes and chicken	244
12.3	The bargaining problem	247
12.4	Iterated games	251
12.5	Game theory and evolution	255
12.6	Game theory and ethics	257
13	Social choice theory	263
13.1	The social choice problem	265
13.2	Arrow's impossibility theorem	268
13.3	Sen on liberalism and the Pareto principle	273
13.4	Harsanyi's utilitarian theorems	276
14	Overview of descriptive decision theory	285
14.1	Observed violations of the expected utility principle	285
14.2	Prospect theory	288
14.3	Violations of transitivity and completeness	290
14.4	The relevance of descriptive decision theory	292
	<i>Appendix A: Glossary</i>	296
	<i>Appendix B: Proof of the von Neumann–Morgenstern theorem</i>	302
	<i>Further reading</i>	308
	<i>Index</i>	314