

Contents

Preface	ix
1 Basic Concepts	1
1.1 Preliminaries	1
1.2 An Illustrative Example	4
1.3 Stochastic Programs: General Formulation	15
1.3.1 Measures and Integrals	16
1.3.2 Deterministic Equivalents	25
1.4 Properties of Recourse Problems	31
1.5 Properties of Probabilistic Constraints	41
1.6 Linear Programming	48
1.6.1 The Feasible Set and Solvability	49
1.6.2 The Simplex Algorithm	59
1.6.3 Duality Statements	64
1.6.4 A Dual Decomposition Method	70
1.7 Nonlinear Programming	75
1.7.1 The Kuhn–Tucker Conditions	77
1.7.2 Solution Techniques	84
1.7.2.1 Cutting-plane methods	84
1.7.2.2 Descent methods	88
1.7.2.3 Penalty methods	91
1.7.2.4 Lagrangian methods	93
1.8 Bibliographical Notes	97
Exercises	99
References	100
2 Dynamic Systems	105
2.1 The Bellman Principle	105
2.2 Dynamic Programming	112
2.3 Deterministic Decision Trees	116
2.4 Stochastic Decision Trees	119

2.5	Stochastic Dynamic Programming	124
2.6	Scenario Aggregation	129
2.6.1	Approximate Scenario Solutions	136
2.7	The Value of Using a Stochastic Model	137
2.7.1	Comparing the Deterministic and Stochastic Objective Values	137
2.7.2	Deterministic Solutions in the Event Tree	138
2.7.3	Expected Value of Perfect Information	140
2.8	Bibliographical Notes	143
	Exercises	143
	References	144
3	Recourse Problems	147
3.1	Outline of Structure	147
3.2	The L-shaped Decomposition Method	149
3.2.1	Feasibility	149
3.2.2	Optimality	155
3.3	Regularized Decomposition	161
3.4	Bounds	165
3.4.1	The Jensen Lower Bound	167
3.4.2	Edmundson–Madansky Upper Bound	168
3.4.3	Combinations	172
3.4.4	A Piecewise Linear Upper Bound	173
3.5	Approximations	178
3.5.1	Refinements of the “Wait-and-See” Solution	178
3.5.2	Using the L-shaped Method within Approximation Schemes	189
3.5.3	What is a Good Partition?	191
3.6	Simple Recourse	193
3.7	Integer First Stage	197
3.7.1	Initialization	203
3.7.2	Feasibility Cuts	203
3.7.3	Optimality Cuts	203
3.7.4	Stopping Criteria	203
3.8	Stochastic Decomposition	205
3.9	Stochastic Quasi-Gradient Methods	213
3.10	Solving Many Similar Linear Programs	218
3.10.1	Randomness in the Objective	221
3.11	Bibliographical Notes	221
	Exercises	223
	References	225
4	Probabilistic Constraints	231

4.1	Joint Chance Constrained Problems	233
4.2	Separate Chance Constraints	235
4.3	Bounding Distribution Functions	237
4.4	Bibliographical Notes	245
	Exercises	246
	References	246
5	Preprocessing	249
5.1	Problem Reduction	249
5.1.1	Finding a Frame	250
5.1.2	Removing Unnecessary Columns	251
5.1.3	Removing Unnecessary Rows	252
5.2	Feasibility in Linear Programs	253
5.2.1	A Small Example	260
5.3	Reducing the Complexity of Feasibility Tests	261
5.4	Bibliographical Notes	262
	Exercises	262
	References	263
6	Network Problems	265
6.1	Terminology	266
6.2	Feasibility in Networks	268
6.2.1	Comparing the LP and Network Cases	276
6.3	Generating Relatively Complete Recourse	277
6.4	An Investment Example	279
6.5	Bounds	283
6.5.1	Piecewise Linear Upper Bounds	284
6.6	Project Scheduling	291
6.6.1	PERT as a Decision Problem	292
6.6.2	Introduction of Randomness	292
6.6.3	Bounds on the Expected Project Duration	294
6.6.3.1	Series reductions	294
6.6.3.2	Parallel reductions	294
6.6.3.3	Disregarding path dependences	294
6.6.3.4	Arc duplications	295
6.6.3.5	Using Jensen's inequality	296
6.7	Bibliographical Notes	296
	Exercises	297
	References	299
	Index	303