

Contents

1 Overview	1
1.1 Importance of Optimization Problems.	1
1.2 Optimization	2
1.2.1 Unconstrained Optimization and Critical Points	2
1.2.2 Constrained Optimization	3
1.2.3 Variational Problems	4
1.2.4 Optimal Control Problems.	4
1.3 Approximation	5
1.4 Structure and Use of the Book	7
 Part I Mathematical Programming	
2 Linear Programming.	11
2.1 Some Motivating Examples	11
2.2 Structure of Linear Programming Problems	14
2.3 Sensitivity and Duality	19
2.4 A Final Clarifying Example	22
2.5 Final Remarks	25
2.6 Exercises	26
2.6.1 Exercises to Support the Main Concepts.	26
2.6.2 Practice Exercises	29
2.6.3 Case Studies	30
3 Nonlinear Programming	33
3.1 Some Motivating Examples	33
3.2 Structure of Non-linear Programming Problems	37
3.3 Optimality Conditions.	38
3.4 Convexity	47
3.5 Duality	52
3.6 Final Remarks	55

3.7	Exercises	56
3.7.1	Exercises to Support the Main Concepts	56
3.7.2	Practice Exercises	58
3.7.3	Case Studies	61
4	Numerical Approximation	63
4.1	Practical Numerical Algorithms for Unconstrained Minimization	64
4.1.1	The Direction	64
4.1.2	Step Size	65
4.2	A Perspective for Constrained Problems Based on Unconstrained Minimization	67
4.2.1	The Algorithm for Several Constraints	70
4.2.2	An Important Issue for the Implementation	72
4.3	Some Selected Examples	73
4.4	Final Remarks	78
4.5	Exercises	78
4.5.1	Exercises to Support the Main Concepts	78
4.5.2	Computer Exercises	81
4.5.3	Case Studies	83
	References	85

Part II Variational Problems

5	Basic Theory for Variational Problems	89
5.1	Some Motivating Examples	89
5.2	Existence of Optimal Solutions	94
5.3	Optimality Conditions Under Smoothness	96
5.4	Constraints	101
5.5	Final Remarks	104
5.6	Exercises	104
5.6.1	Exercises to Support the Main Concepts	104
5.6.2	Practice Exercises	108
5.6.3	Case Studies	111
6	Numerical Approximation of Variational Problems	115
6.1	Importance of the Numerical Treatment	115
6.2	Approximation Under Smoothness	115
6.2.1	The Descent Direction	116
6.3	Approximation Under Constraints	119
6.4	Some Examples	121
6.5	The Algorithm in Pseudocode Form	128
6.6	Exercises	130
6.6.1	Exercises to Support the Main Concepts	130
6.6.2	Computer Exercises	131

6.6.3 Case Studies	133
References.	134

Part III Optimal Control

7 Basic Facts About Optimal Control	139
7.1 Some Motivating Examples	139
7.2 An Easy Existence Result.	142
7.3 Optimality Conditions.	144
7.4 Pontryaguin’s Principle.	150
7.5 Other Important Constraints	156
7.6 Sufficiency of Optimality Conditions	159
7.7 Final Remarks	160
7.8 Exercises	160
7.8.1 Exercises to Support the Main Concepts.	160
7.8.2 Practice Exercises	162
7.8.3 Case Studies	164
8 Numerical Approximation of Basic Optimal Control Problems, and Dynamic Programming	167
8.1 Introduction	167
8.2 Reduction to Variational Problems.	168
8.3 A Much More Demanding Situation.	171
8.4 Dynamic Programming.	175
8.5 Final Remarks	184
8.6 Exercises	185
8.6.1 Exercises to Support the Main Concepts.	185
8.6.2 Computer Exercises.	185
8.6.3 Case Studies	187
References.	189

Part IV Appendix

9 Hints and Solutions to Exercises	193
9.1 Chapter 2	193
9.1.1 Exercises to Support the Main Concepts.	193
9.1.2 Practice Exercises	196
9.1.3 Case Studies	197
9.2 Chapter 3	200
9.2.1 Exercises to Support the Main Concepts.	200
9.2.2 Practice Exercises	202
9.2.3 Case Studies	206

- 9.3 Chapter 4 208
 - 9.3.1 Exercises to Support the Main Concepts. 208
 - 9.3.2 Computer Exercises. 209
 - 9.3.3 Case Studies 211
- 9.4 Chapter 5 214
 - 9.4.1 Exercises to Support the Main Concepts. 214
 - 9.4.2 Practice Exercises 217
 - 9.4.3 Case Studies 220
- 9.5 Chapter 6 224
 - 9.5.1 Exercises to Support the Main Concepts. 224
 - 9.5.2 Computer Exercises. 225
 - 9.5.3 Case Studies 229
- 9.6 Chapter 7 231
 - 9.6.1 Exercises to Support the Main Concepts. 231
 - 9.6.2 Practice Exercises 236
 - 9.6.3 Case Studies 238
- 9.7 Chapter 8 241
 - 9.7.1 Exercises to Support the Main Concepts. 241
 - 9.7.2 Computer Exercises. 242
 - 9.7.3 Case Studies 245



<http://www.springer.com/978-3-319-64842-2>

Optimization and Approximation

Pedregal, P.

2017, XIII, 254 p. 56 illus., Softcover

ISBN: 978-3-319-64842-2