

Contents

1	Introduction and Installation	1
1.1	What is Julia and Why Julia?	2
1.2	Julia in the Cloud: JuliaBox	4
1.3	Installing Julia	6
1.3.1	Installing Gurobi	6
1.3.2	Installing Julia in Windows	6
1.3.3	Installing Julia in Mac OS X	12
1.3.4	Running Julia Scripts	17
1.3.5	Installing CPLEX	18
1.4	Installing IJulia	20
1.5	Package Management	25
1.6	Helpful Resources	26
2	Simple Linear Optimization	29
2.1	Linear Programming (LP) Problems	30
2.2	Alternative Ways of Writing LP Problems	34
2.3	Yet Another Way of Writing LP Problems	37
2.4	Mixed Integer Linear Programming (MILP) Problems	38

3	Basics of the Julia Language	43
3.1	Vector, Matrix, and Array	43
3.2	Tuple	49
3.3	Indices and Ranges	50
3.4	Printing Messages	53
3.5	Collection, Dictionary, and For-Loop	55
3.6	Function	59
3.7	Scope of Variables	61
3.8	Random Number Generation	64
3.9	File Input/Output	67
3.10	Plotting	73
3.10.1	The PyPlot Package	73
3.10.2	Avoiding Type-3 Fonts in PyPlot	78
3.10.3	The Gadfly Package	79
4	Selected Topics in Numerical Methods	81
4.1	Curve Fitting	81
4.2	Numerical Differentiation	86
4.3	Numerical Integration	90
4.4	Automatic Differentiation	92
5	The Simplex Method	97
5.1	A Brief Description of the Simplex Method	97
5.2	Searching All Basic Feasible Solutions	100
5.3	Using the MathProgBase Package	106
5.4	Pivoting in Tableau Form	108
5.5	Implementing the Simplex Method	110
5.5.1	initialize(c, A, b)	113
5.5.2	isOptimal(tableau)	115
5.5.3	pivoting!(tableau)	115
5.5.4	Creating a Module	120
5.6	Next Steps	126
6	Network Optimization Problems	127
6.1	Minimal-Cost Network-Flow Problem	127
6.2	Transportation Problem	138

6.3	Shortest Path Problem	144
6.4	Implementing Dijkstra's Algorithm	150
7	General Optimization Problems	157
7.1	Unconstrained Optimization	157
7.1.1	Line Search	157
7.1.2	Unconstrained Optimization	159
7.1.3	Box-constrained Optimization	160
7.2	Convex Optimization	161
7.3	Nonlinear Optimization	163
7.4	Nonconvex Nonlinear Optimization	166
7.5	Mixed Integer Nonlinear Programming	170
8	Monte Carlo Methods	171
8.1	Probability Distributions	171
8.2	Randomized Linear Program	173
8.3	Estimating the Number of Simple Paths	181
9	Lagrangian Relaxation	191
9.1	Introduction	191
9.1.1	Lower and Upper Bounds	192
9.1.2	Subgradient Optimization	194
9.1.3	Summary	194
9.2	The p -Median Problem	195
9.2.1	Reading the Data File	196
9.2.2	Solving the p -Median Problem Optimally	198
9.2.3	Lagrangian Relaxation	199
9.2.4	Finding Lower Bounds	200
9.2.5	Finding Upper Bounds	204
9.2.6	Updating the Lagrangian Multiplier	206
10	Parameters in Optimization Solvers	219
10.1	Setting CPU Time Limit	219
10.2	Setting the Optimality Gap Tolerance	220
10.3	Warmstart	221
10.4	Big M and Integrality Tolerance	221

10.5	Turning off the Solver Output	223
10.6	Other Solver Parameters	224
11	Useful and Related Packages	225
11.1	Basic Math	225
11.2	Mathematical Programming	226
11.3	Graph and Network	227
11.4	Heuristics	229
11.5	Statistics and Machine Learning	229
	Index	231