

Contents

1. Mathematical programming	1
1.1. Optimization problems and mathematical programs	1
1.2. Linear, integer and quadratic programs	2
1.3. Problem formulation	3
2. Linear programming	1
2.1. Basic concepts	4
2.2. Inequality constraints	6
2.3. Equality constraints	6
2.4. Initial feasible solution and penalty costs	7
2.5. Standard form of the linear problem.	8
2.6. Linear dependence and convex combination of vectors	9
2.7. Convex combinations of vectors and convex sets.	10
2.8. Extreme point solution and basic feasible solution.	10
3. The simplex and the dual simplex methods.	1
3.1. The simplex method	12
3.2. The dual simplex method	17
4. Duality and sensitivity analysis	20
4.1. Symmetric duals	20
4.2. Dual solutions	20
4.3. Unsymmetric duals	21
5. Integer programming: branch-and-bound algorithm	24
5.1. First approximation	24
5.2. Branching.	24
5.3. Bounding	25
5.4. Computational considerations	25
6. Integer programming: cut algorithm.	29
6.1. The Gomory algorithm	29
6.2. Computational considerations	29

7. Integer programming: the transportation algorithm	31
7.1. Formulation of the problem	31
7.2. The transportation algorithm.	31
7.3. An initial feasible solution	32
7.4. Test for optimality	33
7.5. Improving the solution	33
8. Nonlinear programming: single - variable optimization	34
8.1. Nonlinear programming: formulation of the problem.	34
8.2. Local and global optima.	34
8.3. Sequential - search methods	34
8.3.1. Three - point interval search.	35
8.3.2. Fibonacci search	36
8.3.3. Golden - mean search	38
8.4. Concave and convex functions	40
9. Nonlinear programming: multivariable optimization without constraints	42
9.1. Nonlinear programming: formulation of the problem.	42
9.2. Local and global optima.	42
9.3. Gradient vector.	42
9.4. Hessian matrix	43
9.5. The method of steepest ascent	44
9.6. The Newton - Raphson method	47
10. Nonlinear programming: multivariable optimization with constraints.	50
10.1. Formulation of the problem.	50
10.2. Lagrange multipliers	50
10.3. The Newton - Raphson method.	51
11. Network analysis	56
11.1. Networks	56
11.2. Minimum-span problem	57
11.3. Shortest-route problems	58
11.4. Maximal-flow problems	59
References	68