

Numerical Optimization by Moritz Diehl

1. Why Optimization & What Characterizes an Optimization Problem & Mathematical Formulation in Standard Form
2. Definitions & When Do Minimizers Exist & Mathematical Notation & Nonlinear Programming & Linear Programming & Quadratic Programming & General Convex Optimization Problems & Unconstrained Optimization Problems & Non-Differentiable Optimization Problems & Mixed-Integer Programming
3. How to Check Convexity of Functions & Which Sets are Convex and which Operations Preserve Convexity & Examples for Convex Sets & Which Operations Preserve Convexity of Functions & Standard Form of a Convex Optimization Problem
4. Semidefinite Programming & An Optimality Condition for Convex Problems & Lagrange Dual Function and Weak Duality & Strong Duality for Convex Problems
5. Example 4.3 Dual decomposition & Necessary Optimality Conditions & Sufficient Optimality Conditions & Perturbation Analysis introduction of Estimation and Fitting Problems
6. Linear Least Squares & Ill Posed Linear Least Squares & Regularization for Least Squares & Statistical Derivation of Least Squares & L1-Estimation
7. Gauss-Newton Method & Levenberg-Marquardt Method & Exact Newton's Method & Local Convergence Rates
8. Newton Type Methods & A Local Contraction Theorem for Newton Type Iterations
9. Affine Invariance & Local Convergence for Newton Type Optimization Methods & Necessary and Sufficient Conditions for Local Convergence & Line-Search based on Armijo Condition with Backtracking
10. Alternative: Line Search based on the Wolfe Conditions & Global Convergence of Line Search with Armijo Backtracking
11. Trust-Region Methods & The Cauchy Point and How to Compute the TR Step
12. Algorithmic Differentiation & The Forward Mode of AD & The Backward Mode of AD
13. Algorithmic Differentiation Software & introduction of Optimality Conditions for Equality Constrained Problems
14. Constraint Qualification and Linearized Feasible Cone & Second Order Conditions

15. Optimality Conditions & Equality Constrained QP, & Solving the KKT System & Newton Lagrange Method & Quadratic Model Interpretation & Constrained Gauss-Newton
16. Perturbation Analysis & Local Convergence
17. An Equality Constrained BFGS Method & Globalization by Line Search & Careful BFGS Updating
18. Karush-Kuhn-Tucker Necessary Optimality Conditions & Active Constraints and Constraint Qualification
19. Convex Problems
20. Complementarity & Second Order Conditions & Quadratic Programming via Active Set Method
21. Sequential Quadratic Programming & Powell's Classical SQP Algorithm & Interior Point Methods
22. Barrier problem interpretation SCP & Optimal Control Problem Formulation & KKT Conditions of Optimal Control Problems & Sequential Approach to Optimal Control & Backward Differentiation of Sequential Lagrangian & Simultaneous Optimal Control
23. Problem reformulations and useful function approximations
24. Summary of the course

Numerical Optimization with Applications by Wen-Wei Lin

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