

INMA 2460: Nonlinear optimization

I. Nonlinear programming

1. General formulation of minimization problem. Black box concept and iterative methods. Analytical and arithmetical complexity.
2. Uniform grid method. Lower complexity bounds for global optimization.
3. Relaxation and approximation. Optimality conditions.
4. Main inequalities for differentiable and twice differentiable functions.
5. Gradient method. Rate of convergence.
6. Newton method. Rate of convergence.
7. Variable metric schemes.
8. Conjugate gradient methods. Main properties.
9. Methods for constrained minimization: penalty function methods, barrier function methods.

II. Smooth convex programming.

10. Smooth convex functions. Lower complexity bounds.
11. Strongly convex functions. Lower complexity bounds.
12. Gradient method. Rate of convergence.
13. Optimal methods. Derivation and rate of convergence.
14. Constrained minimization problem. Gradient mapping and its properties.
15. Optimal methods for simple convex sets.
16. Minimax problem. Gradient mapping for minimax. Gradient method for minimax problem.
17. Optimal methods for minimax.
18. Problem with functional constraints. Augmented function's approach. Methods for constrained minimization (description of the idea).

III. Nonsmooth convex programming

19. Problem formulation. Lower complexity bounds.
20. Main lemma. Localization sets.
21. Subgradient method (simple sets). Rate of convergence.

- 22. Subgradient method (constrained minimization). Rate of convergence.
- 23. Lower complexity bounds in finite dimension.
- 24. Cutting plane scheme. Center of gravity method.
- 25. Ellipsoid method. Rate of convergence.
- 26. Methods with complete data. Model of nonsmooth function. Kelly method.
- 27. Level method for unconstrained minimization. Efficiency estimates (no proofs).

IV. Structural programming.

- 28. Definition of self-concordant functions. Main properties.
- 29. Newton method for self-concordant functions. Rate of convergence.
- 30. Definition of self-concordant barriers. Main properties.
- 31. Standard minimization problem. Central path. Path-following method.
- 32. Initialization process. Interior-point schemes for the problems with functional constraints.
- 33. Bounds on the parameter of self-concordant barrier.
- 34. Barriers for some structural problems (linear and quadratic problems; semidefinite problems; extremal ellipsoids; separable problems; geometric programming problems; approximation in L_p norms).