

# Outline

## PART I. THEORY

### Chapter 1. Elements of Convex Analysis

- 1.1 Convex sets and Cones
- 1.2 Convex Functions
- 1.3 Subdifferential Calculus
- 1.4 Conjugate Duality

### Chapter 2. Optimality Conditions

- 2.1 Optimality Conditions for Smooth Problems
- 2.2 Optimality Conditions for Non-Smooth Problems

### Chapter 3. Lagrangian Duality

- 3.1 Duality Relations
- 3.2 Decomposition
- 3.3 The Augmented Lagrangian

## PART II OPTIMIZATION METHODS

### Chapter 4. Projected Gradient Methods for Simple Constrained Optimization (spectral gradient method, projection method, non-monotone line search)

### Chapter 5 Penalty and Augmented Lagrangian Methods for Constrained Optimization (quadratic penalty method, augmented Lagrangian method, first-order method)

### Chapter 6 Accelerated Proximal Gradient (APG) Methods for Convex Optimization

- 6.1 APG Methods for Simple Constrained Convex Optimization
- 6.2 Penalty- and Augmented Lagrangian-APG Methods for A Class of Constrained Convex Optimization

### Chapter 7 Methods for Some Structural Optimization

- 7.1 Alternating Direction Methods (ADM) for A Class of Convex Optimization
- 7.2 Difference-of-Convex (DC) Methods

### Chapter 8 Stochastic Gradient Methods

### Chapter 9 Randomized Gradient Methods

## PART III Sparse Optimization and Applications (compressed sensing, group lasso, fused lasso, graphical lasso and multi-graphical lasso, sparse principal component analysis, matrix completion, rank minimization)