## Contents

1	Introduction	2
	.1 Notation	2
2	Convex sets	4
	.1 Affine and convex sets	4
	.2 Some important examples	4
	.3 Operations that preserve convexity	4
	.4 Generalized Inequalities	4
	.5 Separating and Supporting Hyperplanes	4
	.6 Dual Cone	4
3	Convex functions	4
	.1 Basic properties and examples	4
	.2 Operations that preserves convexity	4
	.3 Conjugate function	4
	.4 Log-concave and log-convex functions	4
	.5 Convexity with respect to a generalized inequalities	4
4	Convex optimization problems	4
	.1 Optimization problems	4
	.2 Convex optimization	4
	.3 Linear optimization problems	4
	.4 Quadratic optimization problems	4
	.5 Geometric Programming	4
	.6 Generalized Inequality constraints	4
	.7 Vector Optimization	4
	.8 exercise	4
5	Duality	4
	.1 Lagrange dual function	4
	.2 The Lagrange dual problem	4
	.3 Geometric interpretation	4
	.4 Saddle-point interpretation	4
	.5 Optimality condition	4
	.6 Perturbation and sensitivity analysis	4
	.7 Examples	4
	.8 Theorems of the alternatives	4
	.9 Generalized inequalities	4
	.10 exercise	4
6	Approximation and fitting	4
7	Statistical estimation	4
8	Geometric problems	4
9	Unconstrained minimization	4
	Equality constrained minimization	4
11	Interior-point method	4
<b>12</b>	Appendix A math background	4

## 1 Introduction

## 1.1 Notation

1.  $f: \mathbb{R}^p \to \mathbb{R}^q$  really means  $f: \mathbf{dom} \, f \to \mathbb{R}^q$ 

2	Convex sets
2.1	Affine and convex sets
2.2	Some important examples
2.3	Operations that preserve convexity
2.4	Generalized Inequalities
2.5	Separating and Supporting Hyperplanes
2.6	Dual Cone
3	Convex functions
3.1	Basic properties and examples
3.2	Operations that preserves convexity
3.3	Conjugate function
3.4	Log-concave and log-convex functions
3.5	Convexity with respect to a generalized inequalities
4	Convex optimization problems
4.1	Optimization problems
4.2	Convex optimization
4.3	Linear optimization problems
4.4	Quadratic optimization problems
4.5	Geometric Programming
4.6	Generalized Inequality constraints
4.7	Vector Optimization
4.8	exercise
5	Duality
5.1	Lagrange dual function
5.2	The Lagrange dual problem
5.3	Geometric interpretation
<b>5.4</b>	Saddle-point interpretation
5.5	Optimality condition
5.6	Perturbation and sensitivity analysis
5.7	Examples
5.8	Theorems of the alternatives
5.9	Generalized inequalities
5.10	exercise
6	Approximation and fitting

8 Geometric problems

Statistical estimation

4

7