Optimization Methods in Finance

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1 Linear Algebra

1. Vectors -

   (a) Vector addition.

   (b) Scalar multiplication.

   (c) Vector multiplication.

   (d) Norm of a vector.

   (e) Special vector types.

   (f) Linear Dependence and Independence.

   (g) Spanning sets and bases.

2. Matrices -

   (a) Matrix addition and multiplication.

   (b) Special matrices.

   (c) Determinants.

   (d) The inverse of a matrix.

   (e) Rank of a matrix.

3. Simultaneous equations -

   (a) No solution.

   (b) Unique solution.

   (c) Infinitely many solutions.

2 Convexity

1. Convex Sets.

2. Convex functions.

3. The derivative method for univariate and multivariate functions.

4. Convex optimization theorem.

3 Cones

1. Definition.

2. Pointed cones.

3. Some examples of cones.

4. Dual Cones.

4 Probability

1. Axiomatic definition of probability spaces.

2. Random variables.

3. Probability mass function of a random variable.

4. Cumulative Distribution function of a random variable.

5. Expectation and Variance.

6. Independent Random variables.

7. Linearity of expectation.

8. Conditional linearity of variance.

5 Basic Optimization theory

1. Decision Variables.

2. Constraints.

3. Objective function.

4. Constrained and unconstrained optimization problems.

5. Feasibility problems.

6. Continuous and Discrete Optimization problems.

7. Generic optimization problem.

8. Global maximizer and minimizer.

9. Unbounded problems.

6   Models of optimization

1. Linear and non-linear programming.

2. Quadratic programing.

3. Conic optimization.

4. Integer programming.

5. Dynamic programming.

6. Optimization with data uncertainty.

7. Stochastic programming.

8. Robust optimizaiton.

7   Financial Mathematics

1. Portfolio selection and asset allocation.

2. Pricing and hedging of options.

3. Risk Management.

4. Asset/Liability management.