OM-S20-01: Introduction

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Why study OM

- Designs are often driven by this idea of optimization, be it algorithm design, system design or design in the physical world.
- **Objective 1** Look around yourself and find examples of optimization problems; Learn to state them formally.
- **Objective 2** There are a number of solution schemes depending on the nature of the problem. Can we identify the problem class? Can we learn some of the popular class of solution schemes.
- **Objective 3** Can we realize the problems have structure and some problems are hard to solve. Appreciate the these aspects.
- **Objective 4** Use the ideas in problems around us (whether in your own life or in your research/study!)

Contents of the Course

- LP, IP, MIP, BIP Formulations
- Corner Point method, Branch and Bound, Bala's Algorithm,
- LP Relaxation and Approximate Algorithms
- Solving AX=b, Matrix decomposition's - LU, QR, SVD
- Least Square, least norm, Eigenvalue problems
- Langrange multiplier, KKT conditions
- Simplex method
- Dual problems
- More general Convex optimization
- Non-linear optimization
- Gradient descent and Newton's Method
- Applications: Eg. Sparse coding and dictionary learning

About the Course

- **Organization:** Lectures, Tutorials/Problem Solving/Office Hours/Home Works/Self Study
- **Pre-Requisites** Familiarity with basic math and basic Algorithms, key words from ML/SP.
- **Evaluation** Approximately 50% for exams and 50% for homework's/assignments etc. Regular effort expected.
- **Text Books/References** See moodle
- **Exact Details:** Please wait for add/drop, numbers to settle, TAs to join.

Linear Programming

$$\max_{x_1, x_2} 3x_1 + 2x_2$$

subject to

$$2x_1 + x_2 \leq 6$$

$$7x_1 + 8x_2 \leq 28$$

$$x_1 \geq 0; x_2 \geq 0; x_1 \in R; x_2 \in R$$

- Objective function
- Constraints
- Feasible Region / Solution space
- Feasible Solution (Any point in the feasible region)
- Optimal Solution

Linear Programming

$$\max_x \; Z = c^T x$$

subject to

$$Ax \leq b$$

$$x \geq 0$$

- You will later be asked to formulate other problems in this form and tell what the values of c, A and b will be for that problem.
- How do you modify the objective for a minimization problem?
- What if one of the constraints is $|x_i| < 3$?
- What if one of the constraint is an equation: $|x_i| = 3$?
- The problem with an added constraint of $x \in Z$ ie in the integer space is called IP (integer programming)