Convex Optimization (CS-709)

Instructor: Saketh

1 Goals, Scope and Syllabus

This is primarily a foundational course on convex optimization. The focus however is on topics which might be useful for machine learning and computer vision researchers. Accordingly, some advanced/specialized topics are included:

I. Theory

- Convex Analysis: Convex Sets, Convex Functions, Calculus of convex functions
- Optimality of Convex Programs: 1st order nec. and suff. conditions, KKT conditions
- Duality: Lagrange and Conic duality

II. Standard Convex Programs and Applications

- Linear and Quadratic Programs
- Conic Programs: QCQPs, SOCPs, SDPs

III. Optimization Techniques

- Smooth Problems: (proj.) Gradient descent, Nesterov's accelerated method, Newton's methods
- Nonsmooth Problems: (proj.) Subgradient descent
- Special topics: Stochastic Gradient Descent and variants

Reference text books for the theory part are: [1, 2, 3]; for the subsequent part: [4, 5]; and for the part on optimization methods: [6, 4]. Also, the following video lecture series (available online) provide good insights into the subject [7, 8]. If time permits, we will cover Stochastic methods and the references for this part will be relevant papers.

The following skills are expected to be acquired by students studying this course: recognizing convex problems, re-casting problems as convex ones, adapting suitable solving procedures etc.

2 Evaluation Scheme

The following scheme shall be used for grading:

S.No.	Exam	Weightage	Date
1.	Mid-Semester	28.5%	20^{th}-25^{th} Feb'17
2.	End-Semester	28.5%	15^{th}-29^{th} Apr'17
3.	CodingExam	28.5%	5^{th} May'17 (tentative)
4.	Class-Participation	14.5%	Lecture/tutorial involvement

Relative grading (with appropriate normalization) will be done for each of Mid-Semester, End-Semester, Coding Exam seperately. Then the three grades will be averaged to obtain a 'pre-final' grade. Adjustments to this pre-final grade will be done based on the Class-participation to obtain the final grade. For e.g., if a student's pre-final grade is AB, and he is in the top 35% of students whose pre-final grades are AB, and his class-participation is high, then his final grade will be AA. If a student's pre-final grade is AB, and he is in the bottom 35% of students whose pre-final grades are AB, and his class-participation is weak, then his final grade will be BB, and so on.

3 Contact

The course page is at `http://www.cse.iitb.ac.in/saketh/teaching/cs709.html`. The instructor can be contacted via phone: x7903 or email: saketh at cse. The typical working hours of the instructor are 9:30am to 12:30pm and 2pm to 5pm. His office is in SIA306.You are welcome to dropby for clarifying doubts (if any) during these working hours.

References

[1] R. T. Rockafellar. *Convex Analysis*. Princeton University Press, 1996.

[2] S. Boyd and L. Vandenberghe. *Convex Optimization*. Cambridge University Press, 2004.

[3] D. P. Bertsekas. *Convex Analysis and Optimization*. Athena Scientific, 2003.

[4] A. Nemirovski. Lectures On Modern Convex Optimization. Available freely at `www2.isye.gatech.edu/~nemirovs/Lect_ModConvOpt.pdf`, 2005.

[5] A. Ben-Tal and A. Nemirovski. *Lectures on Modern Convex Optimization: Analysis, Algorithms and Engg. Applications*. MPS-SIAM Series on Optimization, 2001.

[6] Y. Nesterov. *Introductory Lectures on Convex Optimization: A Basic Course*. Kluwer Academic Publishers, 2004.

[7] S. Boyd. Video Lectures on Convex Optimization - 1. Available at `http://www.stanford.edu/class/ee364a/videos.html`, 2007.

[8] S. Boyd. Video Lectures on Convex Optimization - 2. Available at `http://www.stanford.edu/class/ee364b/videos.html`, 2007.