CS6777: Optimization Methods for Computer Vision Applications

Jan-May 2024 Semester
'D' Slot; CS 36
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Note: The course webpage is **http://www.cse.iitm.ac.in/~vplab/optimization.html**. A google group will be formed for course related communications; please check the email regularly.

Course Objectives

In the recent past, algorithms of solving many ill-posed problems in the field of Computer Vision are derived from modern Optimization methods. Allied areas of Machine learning, Pattern recogni- tion and video processing have also seen a rise in the use of such methods. This course will provide an overview of the theories and hands-on practice, required by students and scholars who intend to specialize in this field, to solve complex problems in computer vision and associated fields of study.

Learning Outcomes

- To learn existing optimization algorithms of Computer Vision.
- To cover a range of techniques from classi- cal iterative multidimensional optimization to cutting-edge topics of graph cuts and to- tal variation-based optimization.
- To be aware of recent advances in the field of Optimization.
- To have hands-on experience in implement- ing various Optimization techniques on different datasets.

Course prerequisite(s)

CS6350 or equivalent.

Classroom Mode

Traditional lectures (in D slot), few online lectures.

Textbooks

- Marco Alexander Treiber,"Optimization for Computer Vision: An Introduction to Core Concepts and Methods," Springer 2013.
- Andreas Antoniou and Wu-Sheng Lu, "Practical Optimization: Algorithms and Engineering Applications," Springer 2007.

Reference Books

- Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.
- Alan C. Bovik, Handbook of Image and Video Processing, ELSEVIER, ACA- DEMIC PRESS 2005.
- Stephen Boyd and Lieven Vandenberghe, Convex Optimization, Cambridge University Press 2004.
- Daphne Koller and Nir Friedman, Probabilistic Graphical Models - Principles and Techniques, The MIT Press. 2009.
- Bernhard Scholkopf and Alexander J. Smola, Learning with Kernels - Support Vector Machines, Regularization, Optimiza- tion and Beyond, MIT Press 2002.
- Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press 2016.

Course Requirements

You are required to attend all the lectures. If you miss any of them it is your responsibility to find out what went on during the classes and to collect any materials that may be handed out.

Class participation is strongly encouraged to demonstrate an appropriate level of understanding of the material being discussed in the class. Regular feedback from the class regarding the lectures will be very much appreciated.

Planned Syllabus

- Newton, Gauss-Newton, Quasi-Newton, Sub-Gradient; Levenberg-Marquadrt (LM) Algorithm, Basis Pursuit and LASSO.
- Lagrange Multiplier, Karush Kuhn Tucker (KKT) conditions, First-Order and Second- Order Necessary Conditions for minima and maxima; Convex sets and functions, Convex optimization; Duality, IRLS.
- Few selected topics from: Accelerated Proximal Gradient, ADMM, STAMP & SPADE; Manifold based optimization, L*-norms, Sparse representations and BOVWs, Mul- tiple Kernel Learning (MKL), Latent and Multiple Instance (MI)-learning, Streaming Algorithms.
- Denoising, Deblurring, Depth/motion from Defocus, Super-resolution, TV-ROF & Tikhonov regularization.
- MRF, Max-flow & Min-Cut, Grab Cut, Spectral Clustering, N-Cut, Active contour, GMM, DPMM & Mean Shift Clustering, Particle filter and Subspace clustering.

9 Tentative Grading Policy

The following allocation of points is tentative. These may change during the semester.

End Sem	40
Tutorials [best 2 out of 3]	10
Seminars × [3-4]	20
TPA	30
Total	100

10 Tentative Schedule (Dates)

The following allocation of points is tentative. These may also change during the semester.

Tutorial 1	15 Feb, 2024
Tutorial 2	TBA
Tutorial 3	TBA
Choice of TPA by students	TBA
TPA Assignment to each group	TBA
Interim TPA Review (optional)	TBA
Final TPA Demo/Viva Slot 1	18 May, 2024
Seminar 1	TBA
Seminar 2	TBA
Seminar 3	TBA
End Sem	16 May, 2024

11 Academic Honesty

Academic honesty is expected from each student participating in the course. NO sharing (will- ing, unwilling, knowing, unknowing) of assign- ment code between students, submission of down- loaded code (from the Internet, or anywhere else) is allowed.

Academic violations will be handled by IITM Senate Discipline and Welfare (DISCO) Commit- tee. Typically, the first violation instance will result in ZERO marks for the corresponding com- ponent of the Course Grade and a drop of one- penalty level in final course grade. The second instance of code copying will result in the same as above for marks but drop of two levels of final course grades at the end of semester. The DISCO Committee of IIT Madras will also be intimated of the matter.

Please protect your Moodle account password. Do not share it with ANYONE. Do not share your academic disk drive space on the Campus LAN.

Each proxy in the attendance will be penalized by 5% of (absolute) marks. It becomes 2% each for the donor & beneficiary, if both accept the fault.

Tutorials are not exams. Occasional exchange of technical ideas is permitted, but not copying. No complaints of copying will be entertained after the tutorial. If you find anybody copying, immediately inform the TA's present. If guilty, their copies will be taken away and they will obtain 0 marks for that tutorial. In case if classes are conducted in online mode, recording of any discussions on your digital device without taking permission of the teacher is disallowed. If anyone is found to do that, it will be reported to the Dept/IITM ethical committee. Recorded video lectures may not be distributed to anyone else, other than TAs, registered students. Posting the same on any online/digital media platform is illegal and will also be reported.