Applied Optimization for Wireless, Machine Learning, Big-Data

Electrical Engineering

Instructor Name: Prof. Aditya K. Jagannatham
Institute: IIT Kanpur
Department: Electrical Engineering

Course Intro: : This course is focused on developing the fundamental tools/ techniques in modern optimization as well as illustrating their applications in diverse fields such as Wireless Communication, Signal Processing, Machine Learning, Big-Data and Finance. Various topics will be covered in different areas such as; Wireless: MIMO/ OFDM systems, Beamforming, Cognitive Radio and Cooperative Communication; Signal Processing: Signal Estimation, Regularization, Image Reconstruction; Compressive Sensing: Sparse estimation, OMP, LASSO techniques; Machine Learning: Principal Component Analysis (PCA), Support Vector Machines (SVM); Big-Data: Recommender systems, User-rating prediction, Latent Factor Method; Finance: Financial models, Portfolio Optimization. The course is suitable for all UG/PG students and practicing engineers/ scientists/ managers from the diverse fields mentioned above and interested in learning about the novel cutting edge applications of modern optimization technology.

Pre Requisites: : Basic knowledge of - Calculus, Probability, Matrices
Core/Elective: : Core
UG/PG: : Both
Industry Support : Most companies in Electronics, Communication and Signal Processing. Examples are Qualcomm, Broadcom, Intel, MediaTek, Samsung etc. Companies in Machine Learning, AI, Big-Data and Finance will also find the content useful

Reference : Convex Optimization - Prof Stephen Boyd

About Instructor: Prof. Aditya K. Jagannatham received his Bachelors degree from the Indian Institute of Technology, Bombay and M.S. and Ph.D. degrees from the University of California, San Diego, U.S.A.. From April 07 to May 09 he was employed as a senior wireless systems engineer at Qualcomm Inc., San Diego, California, where he worked on developing 3G UMTS/WCDMA/HSDPA mobile chipsets as part of the Qualcomm CDMA technologies division. His research interests are in the area of next-generation wireless communications and networking, sensor and ad-hoc networks, digital video processing for wireless systems, wireless 3G/4G cellular standards and CDMA/OFDM/MIMO wireless technologies. He has contributed to the 802.11n high throughput wireless LAN standard and has published extensively in leading international journals and conferences. He was awarded the CAL(IT)2 fellowship for pursuing graduate studies at the University of California San Diego and in 2009 he received the Upendra Patel Achievement Award for his efforts towards developing HSDPA/HSUPA/HSPA+ WCDMA technologies at Qualcomm. Since 2009 he has been a faculty member in the Electrical Engineering department at IIT Kanpur, where he is currently an Associate Professor, and is also associated with the BSNL-IITK Telecom Center of Excellence (BITCOE). At IIT Kanpur he has been awarded the P.K. Kelkar Young Faculty Research Fellowship (June 2012 to May 2015) for excellence in research. His popular video lectures for the NPTEL (National Programme on Technology Enhanced Learning) course on Advanced 3G and 4G Wireless Mobile Communications can found at the following YouTube link (NPTEL 3G/4G - http://www.youtube.com/playlist?list=PLbMVogVj5nJSi8FUsvglRxLtN1TN9y4nx).

COURSE PLAN

SL.NO	Week	Module Name
1	1	Introduction to properties of Vectors, Norms, Positive Semi-Definite matrices, Gaussian Random Vectors
2	2	Introduction to Convex Optimization â€“ Convex sets, Hyperplanes Half-spaces etc. Application: Power constraints in Wireless Systems
3	3	Convex Concave Functions, Examples, Conditions for Convexity. Application: Beamforming in Wireless Systems, Multi-User Wireless, Cognitive Radio Systems
4	4	Convex Optimization problems, Linear Program, Application: Power allocation in Multi-cell cooperative OFDM
5	5	QCQP, SOCP Problems, Application: Channel shortening for Wireless Equalization, Robust Beamforming in Wireless Systems
6	6	Duality Principle and KKT Framework for Optimization. Application: Water-filling power allocation, Optimization for MIMO Systems, OFDM Systems and MIMO-OFDM systems
7	7	Optimization for signal estimation, LS, WLS, Regularization. Application: Wireless channel estimation, Image Reconstruction-Deblurring
8	8	Application: Convex optimization for Machine Learning, Principal Component Analysis (PCA), Support Vector Machines
9	9	Application: Cooperative Communication, Optimal Power Allocation for cooperative Communication, Geometric Program
10	10	Application: Cooperative Communication, Optimal Power Allocation for cooperative Communication, Geometric Program
11	11	Application: Radar for target detection, Array Processing, MUSIC, MIMO-Radar Schemes for Enhanced Target Detection

12	12	Application: Convex optimization for Big Data Analytics, Recommender systems, User Rating Prediction, Optimization for Finance