

Course Title	Optimization in ML	Course No.	CSL4xx
Department	Mathematics	Structure (L-T-P [C])	3-0-3 [4.5]
Offered for	B.Tech (AI&DS)	Type	Compulsory
Prerequisite	PRML or Introduction to ML	Antirequisite	Optimization

Objectives

1. To understand the theory of optimization methods and algorithms developed for solving various types of optimization problems
2. To apply the mathematical results and numerical techniques of optimization theory to Machine Learning problems

Learning Outcomes

The students are expected to have the ability to:

1. Compose existing theoretical analysis with new aspects and algorithm variants.
2. Formulate the most important optimization algorithms for machine learning applications

Contents

Introduction to optimization: Machine Learning and Optimization, linear and non-linear optimization, discrete optimization, Network flows, convex sets, functions. (14 Lectures)

Regularizations and SGD: L1 and L2 regularization, First-order methods: gradient descent, acceleration and subgradient method, Stochastic gradient methods, SGD heuristics and tricks, escaping saddle points. (14 Lectures)

Other topics relevant to optimization for ML: Interior point and cutting-plane methods for ML, Min-Max Problems (convex-concave and nonconvex), Non-Euclidean and Submodular optimization. (14 Lectures)

Reference Books

1. S. BOYD, L. VANDENBERGHE (2003), Convex Optimization, Cambridge University Press.
2. S. SRA, S. NOWOZIN, S. WRIGHT, (Eds.), Optimization for Machine Learning, MIT Press, 2011.
3. E. HAZAN (2019), Lecture Notes: Optimization for Machine Learning [<https://arxiv.org/abs/1909.03550>].
4. D. BERTSEKAS (2016), Nonlinear Programming, Athena Scientific, 3rd Edition.

Self Learning Material

1. <http://suvrit.de/teach/6881/>