ESSENTIAL MATHEMATICS FOR MACHINE LEARNING

PROF. SANJEEV KUMAR
Department of Mathematics
IIT Roorkee

PROF. S.K. GUPTA
Department of Mathematics
IIT Roorkee

INTENDED AUDIENCE : UNDERGRADUATE AND POSTGRAUATE STUDENTS OF COMPUTER SCIENCE/MATHEMATICS/DATA SCIENCE

INDUSTRIES APPLICABLE TO : Microsoft/Amazon/Intel

COURSE OUTLINE :

Machine learning (ML) is one of the most popular topics of nowadays research. This particular topic is having applications in all the areas of engineering and sciences. Various tools of machine learning are having a rich mathematical theory. Therefore, in order to develop new algorithms of machine/deep learning, it is necessary to have knowledge of all such mathematical concepts. In this course, we will introduce these basic mathematical concepts related to the machine/deep learning. In particular, we will focus on topics from matrix algebra, calculus, optimization, and probability theory those are having strong linkage with machine learning. Applications of these topics will be introduced in ML with help of some real-life examples.

ABOUT INSTRUCTOR :

Prof. Sanjeev Kumar is working as an associate professor with Department of Mathematics, IIT Roorkee. Earlier, he worked as a postdoctoral fellow with Department of Mathematics and Computer Science, University of Udine, Italy and assistant professor with IIT Roorkee. He is actively involved in teaching and research in the area of computational algorithms, inverse problems and image processing. He has published more than 55 papers in various international journals conferences of repute. He has completed a couple of sponsored research projects and written several chapters in reputed books published with Springer and CRC press.

Prof. S. K. Gupta is an Associate Professor in the Department of Mathematics, IIT Roorkee. His area of expertise includes nonlinear, non-convex and Fuzzy optimization. He has guided three PhD thesis and have published more than 40 papers in various international journals of repute.

COURSE PLAN :

Week 1 : Vectors in Machine Learning, Basics of Matrix Algebra,Vector Space, Subspace, Basis and Dimension.
Week 2 : Linear Transformations, Norms and Spaces, Orthogonal Complement and Projection Mapping, Eigenvalues and Eigenvectors, Special Matrices and Properties.
Week 3 : Spectral Decomposition, Singular Value Decomposition,Low Rank Approximations, Python Implementation of SVD and Low-rank Approximation.
Week 4 : Principal Component Analysis,Python Implementation of PCA, Linear Discriminant Analysis, Python Implementation of LDA.
Week 5 : Least Square Approximation and Minimum Normed Solution, Linear and Multiple Regression, Logistic Regression.
Week 6 : Classification Metrics, Gram Schmidt Process, Polar Decomposition, Minimal Polynomial and Jordan Canonical Form, Some more Matrices Applications in Machine Leaning.
Week 7 : Basics concepts of Calculus, gradient, Jacobian, Chain rule,Change of variables.
Week 8 : Calculus in Python, Convex sets and convex functions, properties of convex functions, Introduction to Optimization.
Week 9 : Numerical Optimization in Machine Learning, Gradient Descent and other optimization algorithms in machine learning.
Week 10 : Optimization using Python, Review of Probability, Bayes theorem and random variable, Expectation and variance.
Week 11 : Discrete and continuous distribution functions, joint probability and covariance, Introduction to SVM, Error minimizing LPP.
Week 12 : Lagrangian Multiplier method, concepts of duality, hard and soft margin classifier, SVM in Python.