


MATHEMATICAL FOUNDATIONS FOR MACHINE LEARNING

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PRE-REQUISITES : Basic Mathematics at school and undergraduate level

INTENDED AUDIENCE : BE/BTech/ME/MTech//BSc/MSc(Maths)/MCA

INDUSTRY SUPPORT : Amazon, Flipkart, Robert Bosch, Qualcomm, Nvidia and Companies that are into Computer vision,Data Science, Robotics and Control

COURSE OUTLINE :

This course will provide a holistic approach to the mathematical foundations for Machine Learning. The course is focussed on developing mathematical ideas, necessary for machine learning applications, through intuitions and visualizations.The course primarily focuses on three important mathematical domains, namely

1. Linear Algebra
2. Probabilty and Statistics and
3. Multivariable Calculus,

on which the ML and data science ideas are built.

ABOUT INSTRUCTOR :

Prof. Ashok Rao is with 30 years of teaching and research experience in the domains of Digital Signal Processing, Linear Algebra, Image Processing, Multimedia and Machine Learning etc. He is a gold medalist from IISc in his MTech degree and holds a PhD from IIT Bombay. He has been awarded Texas Instruments (TI) International DSP Design & Education Award for promoting Excellence in Undergraduate DSP education during 1996-98. He has received Citation from Philips Company for regularly crafting excellent UG students in E & C, in the area of Signal processing & Digital Communication during 96-98.

Prof. Arulalan Rajan is a PhD from IISc with interests in Algorithms and Architectures for Signal Processing and Machine Learning, Applied Linear Algebra, Number Theory, Probabilistic ML and Statistics. He has taught courses on Linear Algebra, Matrix Theory and Stochastic Processes during his tenure, between 2013-19 at NITK Surathkal. He has also co-taught the courses on Mathematical Foundations of Machine Learning, Probability Foundations for Machine Learning and Probability, Statistics and Matrix Methods for Machine Learning at the Centre for Continuing Education in the IISc in the last 5 years.

COURSE PLAN :

Week 1: Vectors, Vector Spaces and Subspaces

Week 2: Linear Transformations, eigenvalues and eigenvectors

Week 3: Orthogonality, Projection and Real symmetric matrices

Week 4: Singular value decomposition, Principal Component Analysis, Support Vector Machines and Applications

Week 5: Probability Foundations - From Events to Bayes' Theorem

Week 6: Random Variables, Moments of Random Variables

Week 7: Jointly Distributed Random Variables, Conditioning of Random variables

Week 8: Limit Theorems, Sample Geometry, Covariance Matrices and Properties

Week 9: Taylor's series, Partial Derivatives, Chain rule, Gradient, Jacobian, Hessian

Week 10: Matrix Derivatives, Gradient Descent and Stochastic Gradient Descent, Constrained and Unconstrained optimization, Lagrangian,

Least Squares and PCA

Week 11: Neural Nets, Perceptron, Back Propagation Algorithm

Week 12: Algorithms for ML - Classification, Clustering and Regression