MSML - MACHINE LEARNING

MSML601 Probability and Statistics (3 Credits)
Provides a solid understanding of the fundamental concepts of probability theory and statistics. The course covers the basic probabilistic concepts such as probability space, random variables and vectors, expectation, covariance, correlation, probability distribution functions, etc. Important classes of discrete and continuous random variables, their inter-relation, and relevance to applications are discussed. Conditional probabilities, the Bayes formula, and properties of jointly distributed random variables are covered. Limit theorems, which investigate the behavior of a sum of a large number of random variables, are discussed. The main concepts random processes are then introduced. The latter part of the course concerns the basic problems of mathematical statistics, in particular, point and interval estimation and hypothesis testing.
Prerequisite: Undergraduate courses in calculus and basic linear algebra.
Cross-listed with: DATA601, BIOI601.
Credit Only Granted for: BIOI601, DATA601 or MSML601.

MSML602 Principles of Data Science (3 Credits)
An introduction to the data science pipeline, i.e., the end-to-end process of going from unstructured, messy data to knowledge and actionable insights. Provides a broad overview of what data science means and systems and tools commonly used for data science, and illustrates the principles of data science through several case studies.
Cross-listed with: DATA602, BIOI602.
Restriction: Must be in one of the following programs: (Data Science Post-Baccalaureate Certificate, Master of Professional Studies in Data Science and Analytics, or Master of Professional Studies in Machine Learning).
Credit Only Granted for: BIOI602, DATA602, MSML602 or CMSC641.
Formerly: CMSC641.

MSML603 Principles of Machine Learning (3 Credits)
A broad introduction to machine learning and statistical pattern recognition. Topics include: Supervised learning: Bayes decision theory, discriminant functions, maximum likelihood estimation, nearest neighbor rule, linear discriminant analysis, support vector machines, neural networks, deep learning networks. Unsupervised learning: clustering, dimensionality reduction, PCA, auto-encoders. The course will also discuss recent applications of machine learning, such as computer vision, data mining, autonomous navigation, and speech recognition.
Cross-listed with: DATA603, BIOI603, MSQC603.
Restriction: Must be in one of the following programs: (Data Science Post-Baccalaureate Certificate, Master of Professional Studies in Data Science and Analytics, or Master of Professional Studies in Machine Learning).
Credit Only Granted for: BIOI603, DATA603, MSML603, MSQC603 or CMSC643.
Formerly: CMSC643.

MSML604 Introduction to Optimization (3 Credits)
Focuses on recognizing, solving, and analyzing optimization problems. Linear algebra overview: vector spaces and matrices, linear transformations, matrix algebra, projections, similarity transformations, norms, eigen-decomposition and SVD. Convex sets, convex functions, duality theory and optimality conditions. Unconstrained optimization: 1D search, steepest descent, Newton's method, conjugate gradient method, DFP and BFGS methods, stochastic gradient descent. Constrained optimization: projected gradient methods, linear programming, quadratic programming, penalty functions, and interior-point methods. Global search methods: simulated annealing, genetic algorithms, particle swarm optimization.
Prerequisite: Undergraduate courses in calculus and basic linear algebra.
Recommended: DATA601.

MSML605 Computing Systems for Machine Learning (3 Credits)
Programming, software and hardware design and implementation issues of computing systems for machine learning. Topics in the programming/software domain will include: basic Python program structure, variables and assignment, built-in data types, flow control, functions and modules; basic I/O, and file operations. Classes, object-oriented programming and exceptions. Regular expressions, database access, network programming and sockets. Introduction to the Numpy, Scipy and Matplotlib libraries. Topics in the hardware domain include computer architecture, CPUs, single- and multi-core architectures, GPUs, memory and I/O systems, persistent storage, and virtual memory. Parallel processing architectures, multiprocessing and cluster processing.
Restriction: Must be in the MPS in Machine Learning program.

MSML606 Algorithms and Data Structures for Machine Learning (3 Credits)
Provides both a broad coverage of basic algorithms and data structures. Topics include sorting, searching, graph and string algorithms; greedy algorithm, branch-and-bound, dynamic programming and job scheduling; Arrays, linked lists, queues, stacks, and hash tables; Algorithm complexity, best/average/worst case analysis. Applications selected from machine learning problems.

MSML612 Deep Learning (3 Credits)
Provides an introduction to the construction and use of deep neural networks: models that are composed of several layers of nonlinear processing. The class will focus on the main features in deep neural nets structures. Specific topics include backpropagation and its importance to reduce the computational cost of the training of the neural nets, various coding tools available and how they use parallelization, and convolutional neural networks. Additional topics may include autoencoders, variational autoencoders, convolutional neural networks, recurrent and recursive neural networks, generative adversarial networks, and attention-based models. The concepts introduced will be illustrated by examples of applications chosen among various classification/clustering questions, computer vision, natural language processing.
Prerequisite: DATA603 or MSML603.
Cross-listed with: DATA612.
Credit Only Granted for: DATA612 or MSML612.

MSML640 Computer Vision (3 Credits)
An introduction to basic concepts and techniques in computer vision. Topics include low-level operations such as image filtering, correlation, edge detection and Fourier analysis. Image segmentation, texture and color analysis. Perspective, cameras and 3D reconstruction of scenes using stereo and structure from motion. Deep learning for object detection, recognition and classification in images and video.
Prerequisite: BIOI603, DATA603, or MSML603.
Cross-listed with: DATA640.
Credit Only Granted for: MSML640 or DATA640.

MSML641 Natural Language Processing (3 Credits)
Introduces fundamental concepts and techniques involved in getting computers to deal more intelligently with human language. Focused primarily on text (as opposed to speech), the class will offer a grounding in core NLP methods for text processing (such as lexical analysis, sequential tagging, syntactic parsing, semantic representations, text classification, unsupervised discovery of latent structure), key ideas in the application of deep learning to language tasks, and consideration of the role of language technology in modern society.
Prerequisite: DATA603 or MSML603.
Cross-listed with: DATA641.
Credit Only Granted for: DATA641 or MSML641.

MSML650 Cloud Computing (3 Credits)
Presents the state of the art in cloud computing technologies and applications. Topics will include: telecommunications needs, architectural models for cloud computing, cloud computing platforms and services. Data center networking, server, network and storage virtualization technologies, and containerization. Cloud operating and orchestration systems. Security, privacy, and trust management; resource allocation and quality of service; interoperability and internetworking.
Cross-listed with: DATA650.
Credit Only Granted for: MSML650 or DATA650.