FS19 MTH994: Machine Learning

Instructor: Guowei Wei – wei@math.msu.edu
Office: D301 Well Hall

Course Description: Machine Learning (ML) is a powerful technique widely used in many data science areas such as finance, insurance, economics, biology, bioinformatics, medicine, engineering, language processing, face recognition etc. In this course, we will not only discuss the theoretical framework of ML algorithms and architectures but also put an emphasis on programming skills so that each student is able to implement advanced ML algorithms for real-world problems. The course starts with linear regression, logistic regressions, k-means, k-nearest neighbors, support vector machine, and decision trees, including random forest and gradient boosting trees. After discussing these elementary materials, more advanced methodologies such as the deep neural network (DNN), back-propagation, convolutional neural network (CNN), recurrent neural network (RNN), and generative adversarial network (GAN), will be studied if time permits. The course will try to help graduate students with their research needs in ML.

Prerequisites: None but assuming a student knows advanced calculus, linear algebra, and has good coding skill.

Text: There is no required textbook for this course.

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Course Description: The second semester course on machine learning (ML) will be focused on advanced techniques and algorithms, including the design and optimization of artificial neural networks (ANN), transfer learning (TL), manifold learning (ML), Long-short term memory (LSTM), reinforcement learning *(*RL*),* capsule network (CapsNet), variational autoencoder (VAE), generative adversarial network (GAN), Boltzmann machine (BM), deep belief network (DBN) etc. We will also discuss research-level topics, such as analyzing the intrinsic dimensionality of dataset encoding, making deep learning more transparent (less a black-box), more efficient, and more robust in the selection of hyperparameters, designing new machine algorithms and reformulating ML algorithms from the mathematical point of view. This course draws on a variety of mathematical subjects, including algebra, topology, geometry, analysis, differential equation, graph theory, optimization, statistics, and probability. This course will involve active research topics in ML.

Prerequisites: A student must have passed the first semester course on ML.

Text: There is no required textbook for this course