Intro to Machine Learning

Tufts CS 135 | Fall 2023

Schedule

Jump to:

[Unit 1: Regression] - [Unit 2: Classification] - [Unit 3: Neural Nets]

[Unit 4: Trees and Ensembles] - [Unit 5: Kernels] - [Unit 6: PCA & Rec. Sys.]

Please complete assigned readings *before* the start of class.

Course Introduction

Concepts: supervised learning, unsupervised learning, difference between ML and AI

Date	Assigned	Do Before Class	Class Content	Optional
Tue 09/05 day01	out: - HW0	**Readings:** - Course syllabus	**Course Overview** **Slides**: - Why take this course? - How will semester go? **Lab Notebook**: - Intro to Arrays in NumPy [colab] - Intro to Pandas and Plotting [colab]	

Unit 1: Regression

Concepts: over-fitting, under-fitting, cross-validation

Methods: Linear regression, k-NN regression

Evaluation: mean squared error, mean absolute error

Work: HW1

Date	Assigned	Do Before Class	Class Content	Optional
Thu 09/07 day02	due on Mon - HW0	**Readings:** - Install your Python environment - - Read ISLP Ch. 1 : - Focus: 'Notation and Simple Matrix Algebra' - - Read ISLP Ch. 2 : Sec. 2.1 & Sec. 2.2 - Focus: 'Parametric Methods' - Focus: 'Assessing Model Accuracy'	**Regression basics** **Slides**: - Regression basics - HW0 tips / doctest guide **Lab Notebook**: - Regr Demo on Abalone [colab]	- Alt. intro to supervised ML: SML Sec. 2.1 - More on k-NN: SML Sec. 2.2: k-NN

		- Focus: 'K-Nearest Neighbors'		
Tue 09/12 day03	out - HW1	**Readings:** - SML Sec. 3.1 - Notes on estimating coefs [PDF]	**Linear regression** **Slides**: - Linear regression - HW0 recap **Lab Notebook**: - Linear Regr. from 1D to any-D [colab]	- Derivation: SML Sec. 3.A - Read MML Textbook Ch. 9 : Sec. 9.1-9.2 - Derivation with probabilistic perspective
Thu 09/14 day04		**Readings:** - Skim ISLP Ch. 3 : - Focus: 3.3.2 Extensions of the Linear Model - Esp. pages 98-99 on 'Non-linear Relationships' - Read ISLP Ch. 5 : - Focus: 5.1.1 Validation Set Approach - Focus: 5.1.3 k-fold Cross-Validation	**Model selection & Cross validation** **Slides**: - Hyperparam. Selection **Lab Notebook**: - Hyperparam Selection [colab]	
Tue 09/19 day05		**Readings:** - Read SML Sec. 3.3 - Read SML Sec. 5.3	**Regularization** **Slides**: - Regularization - HW1 tips **Lab Notebook**: - Regularization: L2 (ridge) vs L1 (lasso) [colab]	- Read: ISLP Ch. 6 : Sec. 6.2.1, 6.2.2, and 6.2.3 - - Video by Prof. A. Ihler (UC-Irvine): Regularization for Linear Regression
Thu 09/21 day06	due: -HW1	**Readings:** - Read SML Sec. 5.4 --- Focus: 'Gradient Descent' in Alg. 5.1	**Gradient Descent** **Slides**: - Gradient Descent **Lab Notebook**: - Gradient Descent in 1D [colab]	- Read DL Textbook Sec. 4.3 : Gradient Descent

Unit 2: Classification

Concepts: feature engineering, hyperparameter selection, gradient descent

Methods: Logistic regression, k-NN classification

Evaluation: ROC curves, confusion matrices, cross entropy

Work: HW2, ProjectA

Date	Assigned	Do Before Class	Class Content	Optional
Tue 09/26 day07	out: -HW2	**Readings:** - Read SML Sec. 3.2 - --- Focus: 'A Statistical View of the Classification Problem - --- Focus: 'The Logistic Regression Model for Binary Classification'	**Classification basics** **Slides**: - Classifier basics **Lab Notebook**: - Binary Classification [colab]	

		- Read SML Sec. 2.2: k-NN - --- Focus: Example 2.3 on k-NN classification		
Thu 09/28 day08	out: -ProjA	**Readings:** - Read SML Sec. 4.6 - --- Focus: 'The Confusion Matrix and the ROC Curve' - --- Focus: 'The F1 Score and the Precision–Recall Curve'	**Evaluating Classifiers** **Slides**: - Evaluating classifiers **Lab Notebook**: - Evaluating Binary Classifiers [colab]	
Tue 10/03 day09		**Readings:** - Read SML Sec. 3.2 - --- Review: 'The Logistic Regression Model for Binary Classification' - --- Focus: Training the Logistic Regression Model by Maximum Likelihood - --- Focus: Predictions and Decision Boundaries	**Logistic Regression** **Slides**: - Log loss & Logistic Regression **Math/Concept Exercises**: - Work on Problem 2 of HW2	
Thu 10/05 day10	due: -HW2	**Readings:** - Read SML Sec. 3.2 - --- Focus: 'Logistic Regression for More Than Two Classes' - Read SML Sec. 5.6	**Multi-class Logistic Regr.** **Slides**: - Multi-class Classifiers - Bag-of-Words **Lab Notebook**: - Bag of Words [colab]	

Unit 3: Neural Nets

Concepts: backpropagation, stochastic gradient descent

Methods: multi-layer perceptrons for regression and classification

Work: HW3

Date	Assigned	Do Before Class	Class Content	Optional
Tue 10/10 day11		**Readings:** - Read SML Sec. 6.1 - --- Focus: 'Two-Layer Neural Network' - --- Focus: 'Deep Neural Network' - --- Focus: 'Neural Networks for Classification'	**Neural Net basics** **Slides**: - Neural Net Basics **Math/Concept Exercises**: - Universal Approx. Demo **Lab Notebook**: - Neural Nets: MLP for XOR [colab]	
Thu 10/12 day12		**Readings:** - Read SML Sec. 6.2 - --- Focus: 'Backpropagation' - --- Focus: 'Algorithm 6.1 and Example 6.2'	**Training Neural Nets** **Slides**: - Forward prop & Back prop **Math/Concept Exercises**: - Backprop Visualized, from Google's ML Crash Course **Lab Notebook**: - Forward and Backward for MLPs [colab]	
Tue 10/17 day13		**Readings:**	**Midterm Review / Proj. A Work**	

		- n/a	**Day**	
Thu 10/19 day14	due: -ProjA	**Readings:** - Read SML Sec. 5.5 - --- Focus: 'Stochastic Gradient Descent' - --- Skim: 'Learning Rate and Convergence for Stochastic Gradient Descent' - --- Skim: 'Adaptive Methods'	**Stochastic Gradient Descent** **Slides**: - L-BFGS and SGD **Lab Notebook**: - SGD for Linear Regr. & MLPs [colab]	- Read SML Sec. 5.4 - --- Focus: 'Second order Gradient Methods'
Tue 10/24 day15		**Readings:** - SML Sec. 6.3 - --- Focus: 'Convolutional Layer' - --- Focus: 'Pooling Layer'	**Neural Nets 2** **Slides**: - From MLP to CNN and ResNet **Math/Concept Exercises**: - start problem 4 of HW3	
Thu 10/26 day16			**MIDTERM EXAM**	

Unit 4: Trees and Ensembles

Concepts: greedy training, bagging, boosting

Methods: decision trees, random forests, XGBoost

Work: HW4

Date	Assigned	Do Before Class	Class Content	Optional
Tue 10/31 day17		**Readings:** - SML Sec. 2.3 - --- Focus: Example 2.5 - --- Focus: Example 2.6	**Decision Trees** **Slides**: - Decision tree basics **Lab Notebook**: - Decision Trees [colab]	
Thu 11/02 day18	due: - HW3	**Readings:** - Read SML Sec. 7.1 on Bagging - Read SML Sec. 7.2 on Random Forest - Skim SML Sec. 7.4 on Boosting	**Ensembles** **Slides**: - Ensembles of trees **Lab Notebook**: - Random Forest [colab]	
Tue 11/07			**<--- No Class ---> : Tufts Fri on Tue**	
Thu 11/09 day19		**Readings:** - Sec. 1 of Foundation Models paper - --- Sec. 1.1: Emergence and homogenization - --- Sec. 1.2: Social impact and the foundation models ecosystem - --- Sec. 1.3: The future of foundation models`	**Foundation models** **Slides**: - Foundation models	- Stochastic Parrots paper by Bender, Gebru et al.

Unit 5: Kernel Methods

Concepts: kernel functions

Methods: kernelized linear regression, support vector machines

Work: HW5

Date	Assigned	Do Before Class	Class Content	Optional
Tue 11/14 day20		**Readings:** - Read SML Sec. 8.1 - Read SML Sec. 8.2	**Kernel Methods** **Slides**: - Kernels for Regression and Classification **Lab Notebook**: - Kernels for Regr. and Clf. [colab]	
Thu 11/16 day21	due: -HW4	**Readings:** - Read SML Sec. 8.5	**Support Vector Machines** **Slides**: - SVMs **Lab Notebook**: - SVM demo [colab]	

Unit 6: PCA and Recommender Systems

Concepts: dimensionality reduction, matrix factorization, recommendation systems

Methods: principal components analysis, collaborative filtering models

Work: HW5

Date	Assigned	Do Before Class	Class Content	Optional
Tue 11/21 day22		**Readings:** - Read SML Sec. 10.4 - --- Skim: 'Auto-encoders' - --- Focus: 'Principal Component Analysis' in SML 10.4.2 PCA	**Principal Component Analysis (PCA)** **Slides**: - PCA **Lab Notebook**: - PCA demo [colab]	
Thu 11/23			**<--- No Class --->: Thanksgiving**	
Tue 11/28 day23	out: - HW5	**Readings:** - Read Koren et al. '09	**Recomender Systems** **Slides**: - Recommender Systems **Math/Concept Exercises**: - start HW5	- Read recent survey on Deep Learning Based Recommender System
Thu 11/30 day24	due: - ProjB	**Readings:** - Read SML Ch. 11.2	**Project B work-day** **Slides**: - Proj B tips	
Tue 12/05 day25		**Readings:** - Read SML Ch. 12 : Ethics in ML - --> Focus on Sec.	**Fairness** **Slides**: - Fairness	

		12.1 'Fairness and Error Functions' - --> Focus on Sec. 12.2 'Misleading Claims about Performance'	**Math/Concept Exercises**: - Credit Score Fairness Demo	
Thu 12/07 day26	due: - HW5		**Final Exam Review** **Slides**: - Final Review **Math/Concept Exercises**: - practice exam on Piazza	
Fri 12/15			**FINAL EXAM**	