**ECE 2195: Learning Objectives**

**Introduction to machine learning**

* Explain when we need machine learning
* Describe workflow of machine learning process
* Describe difference between machine learning types (e.g. supervised and unsupervised learning)
* List applications
* Differentiate between classification and regression
* Assess machine learning accuracy
* Explain the machine learning performance trade-offs
* Describe KNN classification
* Implementation with Python / Jupyter notebook

**Linear regression, regularization, cross-validation**

* Explain how regression can be performed with single and multiple features
* Formulate a linear regression model
* Explain methods for fitting the model
* Derive the least squared fit of linear regression
* Describe how to find features that are associated with the response
* Calculate metrics to assess the learning performance
* Show how to include qualitative features in a linear regression model
* Use linear regression to model non-linear relationships
* Compare K Nearest Neighbor regression method and linear regression method
* Describe why we need regularization
* Explain the differences between Ridge and Lasso regression
* Explain how can we decide on the best model
* Describe how K-fold cross-validation is implemented
* Describe what is the leave one out cross-validation
* Apply regression to real-world examples using Python

**Classifiers and density estimation**

* Model logistic regression, and formulate then optimize its optimize
* Solve density estimation problems
* Show how do LDA and QDA work
* List the main difference between QDA and Naive Bayes Classification.
* Explain when and why error rate may not be sufficient in evaluating classification accuracy
* Describe what is confusion matrix, precision, recall, and ROC

**Decision trees, ensemble methods, SVMs, neural nets**

* Describe how support vector classifier (SVC) works
* Describe the main objective of support vector machines
* Explain the purpose of the kernel
* List possible kernel functions in SVM
* Explain how decision trees work
* Show how decision trees are applied for both regression and classification problems
* Describe bagging, boosting and random forests. What is their main purpose and how do they differ?
* Explain how neural networks extend the linear models
* List advantages and disadvantages of neural networks
* List the processing stages in deep neural networks

**Dimensionality reduction and unsupervised learning**

* Explain why dimensionality reduction is needed
* Describe the main characteristics of PCA
* Explain how principal components can be selected
* Describe LDA for dimensionality reduction
* Explain how clustering algorithms (K-means, DBSCAN, agglomerative) work
* Formulate mixed Gaussian models problem for unlabeled data
* Describe how the expectation-maximization algorithm finds a solution for an optimization problem and when we would need it