Fundamentals of Machine Learning

EEL 5840
Class Periods: T, period 4, 10:40 AM – 11:30 AM
R, period 4-5, 10:40 AM – 12:35 PM
Location: NEB 202
Academic Term: Spring 2026

Instructor:
Dr. Catia S. Silva
Email: catiaspsilva@ece.ufl.edu
Office: MALA 3122
Office Hours: Wednesdays 10am – 11:30am, or by appointment

Supervised Teacher (ST):
Joseph Arthur Conroy, jconroy@ufl.edu, Office Hours: TBD

Teaching Assistant (TA):
Peter Forcha, peter.forcha@ufl.edu, Office Hours: TBD

Course Description
Understand and utilize the concepts of machine learning for data science and electrical engineering. Focus on tools for multivariate data analysis and how to handle uncertainty in data with probabilistic models.

Course Pre-Requisites / Co-Requisites
Required: None.
Expected: As a graduate course, this course expects all registered students to have completed undergraduate or graduate-level courses in probability theory, statistics, linear algebra, and programming (Python preferred).
Additional: Students *may not* take this course if they have already taken EEE 4773.

Course Objectives
Understand and utilize the concepts of machine learning for data science and electrical engineering. Focus on tools for multivariate data analysis and how to analyze uncertainty in data with probabilistic models.

By the end of the course, students will be able to:

- Explain core concepts and terminology in machine learning and distinguish among supervised and unsupervised learning approaches.
- Apply supervised learning methods for regression and classification tasks, including linear regression, logistic regression, perceptron, discriminant analysis, and support vector machines.
- Evaluate and improve models through regularization, cross-validation, hyperparameter tuning, and performance metrics to ensure robust generalization.
- Implement probabilistic and statistical approaches, including Maximum Likelihood Estimation (MLE), Maximum A Posteriori (MAP), Naïve Bayes, and conjugate priors.
- Use unsupervised learning techniques for clustering and dimensionality reduction, such as k-means, fuzzy clustering, Gaussian mixture models, EM, and PCA.
- Design, train, and optimize neural network models, including multi-layer perceptrons, convolutional neural networks, and transfer learning strategies.
- Communicate machine learning solutions effectively through coding, written reports, and a final project, demonstrating both theoretical understanding and practical implementation skills.

Materials and Supply Fees
None

Required Textbooks and Software

After the drop and add week, all registered students will be added to a HiPerGator group with computing resources for the entire semester. If you prefer to use your own system to participate in course activities, you will need a computer with the following software installed:

- Anaconda Distribution package
- Git

Please also refer to the minimum and suggested specifications for a personal computing device.

Recommended Materials

All textbooks may be accessed in a digital format via the Library Couse Reserves to all students (easy access to the Reserves within Canvas).

- *Pattern Recognition and Machine Learning*
  - Christopher M. **Bishop**
  - Springer, 2006
  - ISBN: 978-0-38731-073-2
  - Website: https://www.microsoft.com/en-us/research/people/cmbishop/prml-book/
- *Mathematics for Machine Learning*
  - Marc Peter **Deisenroth**, A. Aldo Faisal, and Cheng Soon
  - Cambridge University Press, 2020
  - ISBN: 978-1-108-45514-5
  - Website: https://mml-book.github.io/
- *Introduction to Machine Learning*
  - Ethem **Alpaydin**
  - MIT Press, 3rd edition, 2014
  - ISBN: 978-8-120-35078-6
  - Available for free through UF Library Course Reserves

Required Computer

UF student computing requirement: *https://news.it.ufl.edu/education/student-computing-requirements-for-uf/*

Course Schedule

The following course schedule is tentative and may vary due to time constraints or class interests.

Week	Lecture	Topic/s	Assessments
Week 1	1	Introduction to the course. Introduction to types of learning in machine learning and general terminology.	Quiz 0 Assign
Week 2	2	Supervised learning for regression tasks. Linear regression with non-linear features & its code implementation.	
	3	Regularization and cross-validation.	Quiz 0 Due Quiz 1 Assign
Week 3	4	Hyperparameter tuning. The Curse of Dimensionality.	
	5	Maximum Likelihood Estimation (MLE).	Quiz 1 Due Quiz 2 Assign
Week 4	6	Maximum A Posteriori (MAP). Conjugate Prior.	
	7	Supervised learning for classification tasks. Naïve Bayes Classifier.	Quiz 2 Due HW 1 Assign
Week 5	8	**HiPerGator** info session.	
	9	Unsupervised learning for clustering tasks. (Gaussian) Mixture Models.	HW 1 Due Quiz 3 Assign
Week 6	10	Expectation-Maximization (EM) algorithm.	
	11	Cluster validity metrics.	Quiz 3 Due

			HW2 Assign
Week 7	12	k-Means Clustering.	
	13	Fuzzy clustering. Fuzzy C-Means & Possibilistic C-Means.	Final Project Assign
Week 8	14	Midterm Exam Review.	HW2 Due
	15	K-Nearest Neighbors (KNN).	
Midterm Exam – Thursday, March 12 at 8:20 PM – 10:20 PM			
Week 9	16	Supervised learning for classification tasks. The Perceptron Algorithm. Stochastic Gradient Descent.	
	17	Linear Discriminant Functions. Fisher's Linear Discriminant Analysis (FLDA).	Quiz 4 Assign
Week 10	18	Logistic Regression.	
	19	Kernel Machines. Constrained Optimization with Lagrange Multipliers.	Quiz 4 Due Quiz 5 Assign
Week 11	20	Hard-margin Support Vector Machine (SVM).	
	21	Slack variables. Soft-margin SVM.	Quiz 5 Due HW3 Assign
Week 12	22	Unsupervised learning for dimensionality reduction tasks. Principal Component Analysis (PCA).	
	23	Introduction to Deep Learning. Multi-Layer Perceptron (MLP). Backpropagation.	
Week 13	24	Best practices for training artificial neural networks (ANNs).	HW3 Due HW 4 Assign
	25	Best practices continued & code implementations.	
Week 14	26	Convolutional Neural Networks (CNNs).	
	27	Transfer Learning. Final project discussions.	HW4 Due
Week 15	28	Final Exam Review.	Final Project Due
Final Exam –Friday, May 1 at 7:30 AM – 9:30 AM			

Attendance Policy, Class Expectations, and Make-Up Policy
Excused absences must be consistent with university policies in the Graduate Catalog (https://catalog.ufl.edu/graduate/regulations) and require appropriate documentation.

Expectations: I will prepare course lectures with the expectation that students will attend class synchronously and bring a computer to follow along with any practical implementations. Makeups for exams, homework assignments, and weekly assignments are NOT normally allowed. If you cannot attend an exam, you must contact the instructor well in advance (at least 7 days before an announced exam date). Failure to contact the instructor prior to the exam will result in a zero. Please also note that late submission of an exam, homework assignment, or weekly assignment will result in a zero. Arrangements will be made for students on a case-by-case basis for excused reasons. It is every student's responsibility to honor and respect the given deadlines posted on the Canvas course site (https://elearning.ufl.edu).

Evaluation of Grades
The course evaluation will be based on two exams, homework, quizzes, and one final project.
Description of assignments:

- **Homework:** will consist of practical and theoretical understanding of the topics covered in class. A typical homework will have two components: Part I – consists of a quiz that will assess theoretical understanding; Part II – consists of practical problem/s to be implemented in Python.

- **Quizzes:** will consist of exercises for direct application of topics learned in class, it can include code implementation, data analysis or derivations. These assignments have a shorter timeframe for completion than a typical homework.

- **Exams:** the exams will be drawn evenly from all lectures, assignments, and readings that occurred up to that point in the course. The exams will have similar questions to those asked in Part I of homework and short assignments. The final exam does not include content from lectures prior to the midterm, although some concepts are in nature cumulative. You are responsible for all assigned material. A full practice exam(s) will be posted in canvas.

- **Final Project:** The final project is a group assignment. The objective of this project is to implement an end- to-end Machine Learning/Deep Learning model using a data set collected from students in the class. The outcomes of the final project include working code and accompanying README file, recorded demo, and report.

Note: Undergraduate and graduate sections are co-listed; graduate students will have additional questions on exams and assignments and will be graded on a separate final grade curve.

Assignment	Total Points	Total	Percentage of Final Grade
Homework	100 each	4	15%
Quizzes	10 each	6	15%
Midterm Exam	100	1	25%
Final Exam	100	1	25%
Final Project	100	1	20%
			100%

Grading Policy

Percent	Grade	Grade Points
93.4 - 100	A	4.00
90.0 - 93.3	A-	3.67
86.7 - 89.9	B+	3.33
83.4 - 86.6	B	3.00
80.0 - 83.3	B-	2.67
76.7 - 79.9	C+	2.33
73.4 - 76.6	C	2.00
70.0 - 73.3	C-	1.67
66.7 - 69.9	D+	1.33
63.4 - 66.6	D	1.00
60.0 - 63.3	D-	0.67
0 - 59.9	E	0.00

More information on UF grading policy may be found at:
http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#grades

Policy for Use of AI Tools

In this course, generative AI should be regarded as if you are collaborating with a human. The same rules apply; you may discuss ideas, explore approaches, and use AI as a partner in problem-solving. However, just as you would not copy another person's assignment, you may not copy work directly from AI. All submitted work must reflect your

own understanding and effort. Copying work directly from AI, just like copying another person's assignment, is prohibited and considered academic dishonesty.

Code Policy

In this course, students are expected to write their own code for all assignments. You are the one who is being tasked with coming up with a solution to the various AI problems in this course—not your friend, not your roommate, not a stranger on the Internet or any AI-code generators. The reasoning behind this is that later in your educational career it will be expected that you are capable of solving problems on your own, if and when the need arises. Even in a team-based environment, each member of that team must be capable of carrying their own weight**. Unless otherwise noted, there are no group or collaborative assignments in this course**. When working on assignments, discussion of those assignments with your classmates is not only inevitable, but it is strongly encouraged! (We often learn very effectively in social environments.) That said, you should discuss the problem in high level terms, not telling someone else (or being told) how to complete the work. Here are some examples of what could be considered acceptable and unacceptable:

ACCEPTABLE:

- Talking about the problem
- Using a whiteboard (or paper, or something similar) to draw out the problem
- Looking at someone else's work to help them identify or fix a bug, AFTER you have already completed that portion for yourself

UNACCEPTABLE:

- Splitting an assignment's work into multiple parts with other students
- Asking someone to send you their work
- Copying someone else's work into your own submission
- Giving another student your work for ANY reason, once you send your work to someone else, you have no control over where it ends up
- Giving another student step-by-step instructions on how to structure a solution to a problem
- Looking up solutions to problems and using those solutions yourself verbatim
- Viewing solutions to the problems and mimicking those solutions

If you're unsure about the acceptable use of AI tools for your work, ask for clarification! Always refer to the "Policy for Use of AI Tools" information available on Canvas to ensure you stay within the guidelines. Don't hesitate, it's better to ask than to risk violating the policy.

EXPECTATIONS: I expect all students to be bound to the honor pledge as indicated in the student honor code. If you are not capable of completing an assignment on your own, that's okay. Lots of things in life can take time to really "click" for us, and we all learn at different rates. Under no circumstances should you ever consider cheating, that is, submitting someone else's work as your own, as an option. The consequences for doing so will be far worse than if you simply did not do the assignment. Students will complete this course with honor and integrity, or not at all. Submissions which are believed to be not entirely a student's own work will be reported to administration for disciplinary action. Students who commit any of the unacceptable acts listed above will also be reported. In ALL cases, I will recommend the following sanctions be imposed on that student or students:

1. **A failing grade (an 'E') for the course**
2. **That you not be allowed to drop the course for any reason**

Academic Policies & Resources

For academic policies and campus resources, go to https://go.ufl.edu/syllabuspolicies.