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 100
Academic Term: Fall 2025

Instructor:
Dr. Catia S. Silva
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Office Hours: Wednesdays 10am – 11:30am, or by appointment

Supervised Teacher (ST):
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Teaching Assistant (TA):
Peter Forcha, peter.forcha@ufl.edu, Office Hours: Fridays 9:30-11:30am

Undergraduate Peer Instructor (UPI):
Erik Bloomquist, erikbloomquist@ufl.edu, Office Hours: Mondays 9:35-10:25am and Wednesdays 9:35-10:25am

Course Description
(3 credits) 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 – CAMPUS section – Monday, October 13 at 7:20 PM – 9:20 PM Midterm Exam – ONLINE section(s) – anytime on Monday, October 13			
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 – CAMPUS section – Thursday, December 11 at 10:00 AM – 12:00 PM Final Exam – ONLINE section(s) – anytime on Thursday, December 11			

Attendance Policy, Class Expectations, and Make-Up Policy
Please carefully read the following course policies and expectations, and make-up policies:

1. **Course Communications**

General information: (a) The primary means to get help with a problem, other than office hours, will be Slack channel. We will check the board daily, to answer inquiries. Other students should feel free to post responses to these questions as well within the guidelines discussed in the sections on collation and course etiquette. **(b)** Questions about grades or personal issues may be email to me at catiaspsilva@ece.ufl.edu (or any member of the teaching team) or within Canvas. You are welcome to use the telephone (352.392.6502), talk with me during office hours, or setup an appointment. **(c)** We have a Slack page for the course uf-ece-fml-fall25.slack.com. This is an optional

resource for students to discuss the course amongst each other and with the Professor. This resource is intended to supplement office hours and student interactions. No official communication/submission happens over Slack. No assignment submissions will be accepted over Slack.

Expectations: If you have an issue or need help, do not wait to ask about it! Problems are generally easier to solve sooner rather than later. You are expected to contribute to the ongoing constructive feedback that is an essential part of the learning process.

2. **Attendance Policy**

General Information: attendance is not required though summative and cumulative assessments, such as practice quizzes, collaborative teamwork, graded exercises, or participation, may happen during synchronous class meetings (including in an online setting, if any).

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.

3. **Grading Policy**

General Information: (a) All assignments will have a grading rubric and submissions will be graded based on the assignment's rubric. For maximum credit, students must submit correct and elaborated answers that follow instructions. For assignments that required code, clean, easy to read, and well commended Python code is required. **(b)** Individual assignments will not be graded on a curve. Final course grades will be graded on a curve.

Expectations: I will expect that students complete all assignments with care, ensure that submissions are complete and illustrate the understanding of the concepts being assessed.

4. **Late Work**

General Information: all submissions are accepted until the assignment solutions are posted but will lose the "on-time" points listed in the rubric (generally listed at 10% of the grade).

Expectations: I will expect students to follow all deadlines. In case of conflict, I expect that students will communicate with me and let me know well in advance about any conflicting issues to avoid losing the "on-time" points.

5. **Make-Up Policy**

General Information: (a) If you feel that any graded assignment needs to be re-graded, you must discuss this with the instructor or the TA team within one week of grades being posted for that assignment. If approved, the entire assignment will be subject to complete evaluation. **(b)** If you have an academic conflict with any assignment or exam date/time, please let the instructor know well in advance so we can make the necessary changes and make the appropriate accommodations available.

Expectations: I will expect that students will communicate with me and let me know well in advance about any conflict or time/date change requests. Excused absences must be consistent with university policies in the Graduate Catalog (https://catalog.ufl.edu/graduate/regulations) and require appropriate documentation. Additional information can be found here: https://catalog.ufl.edu/graduate/regulations/.

6. **Collaboration**

General Information: in solving any individual assignments, healthy discussion and collaboration amongst classmates is encouraged. Healthy collaboration includes: **(a)** discussing and explaining general course material; **(b)** discussing assignments for better understanding; **(c)** aiding for general programming and debugging issues.

Expectations: If another student contributes substantially to your understanding of a problem, you should cite this student to let myself and the teaching team be aware of your similar interpretations of a problem. You will not be negatively judged for citing another student.

7. Cheating and Plagiarism

General Information: while collaboration is encouraged, you are expected to submit your own work and follow the student honor code. Submitting work completed by another student is considered plagiarism and will be dealt according to university policy. In general, if you do not understand your solution, the work is not your own. Examples of plagiarism include: **(a)** copying (or allowing someone to copy), even partially, an assignment solution or program from the course; **(b)** submitting material taken from another source without proper citation; **(c)** obtaining solutions to assignments or exams through inappropriate means. Note that I may elect to use a plagiarism detection service in this course, in which case you will be required to submit your work to such a service as part of your assignment.

Expectations: I expect all students to be bound to the honor pledge as indicated in the student honor code. If you are suspected of dishonest academic activity, I will invite you to discuss it further in private. Academic dishonesty will likely result in grade reduction, with severity depending on the nature of the dishonest activity. I am obligated to report on academic misconduct with a letter to the department, college and/or university leadership. Repeat offences will be treated with significantly greater severity.

8. Course Etiquette

- Be present. This will allow you to get the most out of class time as well as for your classmates to get the most out of their collaborations with you.
- Put your cell phone away unless you are actively using it to further the class activities.
- Be prepared. The readings and videos are carefully chosen to support the in-class activities.
- Listen carefully and do not interrupt others.
- Give quality feedback. What constitutes "quality" will be discussed in class.
- Respect the opinions of others, even when you do not agree.
- Keep an open mind, embrace the opportunity to learn something new.
- Avoid monopolizing the discussion. Give others a chance to contribute and be heard.
- Do not be afraid to revise your ideas as you gather more information.
- Try to look at issues from more than one perspective.
- Respect others by learning and using the name and pronoun they prefer.
- Do not use offensive language.

Evaluation of Grades

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

Assignment descriptions

- **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.

- **Practicals:** 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, live demo, and poster and its presentation.

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.

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:
https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx.

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

AI Policy
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.