Fundamentals of Machine Learning
EEE 4773 Section 0001
Class Periods: T, period 2-3, 8:30 AM – 10:25 AM,
R, period 3, 9:35 AM – 10:25 AM
Location: LAR 330
Academic Term: Spring 2023

Instructor: Dr. Catia S. Silva
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Office Hours: Wednesdays 2:00 PM – 4:00 PM, Thursdays 11:30 AM – 1:00 PM
Slack: uf-ECE-FundML-spring2023.slack.com

Teaching Assistant/Supervised Teacher:
TBD

Course Description
(3 credits) Overview of machine intelligence and the role of machine learning in a variety of real-world problems. Probability and statistics to handle uncertain data. Topics covered include learning models from data in both a supervised and unsupervised fashion, linear models and non-linear models for classification, and linear dimensionality reduction.

Course Pre-Requisites / Co-Requisites
- EEL 3850 (Data Science for ECE) or equivalent
- EEL 3135 (Introduction to Signals & Systems) or equivalent

Course Objectives
Upon completion of this course, the student will be able to:
- Identify relevant real-world problems as instances of canonical machine learning problems
- Design and implement effective strategies for data preprocessing
- Explain and utilize concepts of machine learning for data science and electrical engineering
- Compare and contrast evaluation metrics
- Foresee and mitigate human-based liabilities of machine learning algorithms
- General level of competency in critical questioning and analysis
- Students will know how to make connections between different fields of machine learning

The main goal of this course is to equip the students with a machine learning mindset for successful practical implementations, in particular: understand, analyze and design an approach to work with a data science or electrical engineering problem.

Materials and Supply Fees:
None

Required Textbooks and Software

1. **Required Software/Hardware:**
   - A computer with the following software installed:
     - Python 3.4.3 or later
     - Anaconda Distribution
     - Git
     - GitHub Desktop

Please see the computer requirements for minimum hardware requirements.

2. **Required Textbooks:**
   - **Pattern Recognition and Machine Learning**
     - Christopher Bishop
     - Springer, 2006
     - ISBN: 978-0-38731-073-2

   The textbook is freely available as a digital pdf and is perfectly fine for this course.

Recommended Materials

- **Introduction to Machine Learning**
  - Ethem Alpaydin
  - 3rd edition
  - The MIT Press, 2014
  - ISBN: 978-8-120-35078-6

  This book is freely available online via Course Reserves (you can easily access it under the "Course Reserves" tab in our Canvas page)

- **Mathematics for Machine Learning**
  - Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon
  - Cambridge University Press, 2020
  - ISBN: 978-1-108-45514-5

  The textbook is freely available as a digital pdf and is perfectly fine for this course.

All textbooks are listed and available online through Course Reserves. You can also find this information under the icon "Course Reserves" in our Canvas page.

Course Schedule

The following schedule is tentative and may vary due to time constraints.

Module	Lecture	Day	Topic/s	Assignments
1. Introduction to Machine Learning	1	T, 01/10	• What is Machine Learning? • Introduction to Git, Jupyter Notebooks and Python • Types of learning • Introduction to Supervised Learning with linear regression • Model selection; Occam's Razor	D0 SA0
2. Experimental Design and Analysis	2	R, 01/12	• Generalization • Regularization • The Bias-Variance Trade-Off • The No Free Lunch Theorem	SA1
	3	T, 01/17	• Experimental Design • Hyperparameter tuning; Cross-validation • The Curse of Dimensionality	
3. Bayesian Learning	4	R, 01/19	• Maximum Likelihood Estimation (MLE) • Maximum A Posteriori (MAP)	D1 HW1
	5	T, 01/24	• Bayesian Prior Equivalence	
	6	R, 01/26	• **HiperGator help session** • Introduction to Classification	**SA2** **D2**

			• Naïve Bayes Classifier	
4. Generative Classification	7	T, 01/31	• Mixture Models • Expectation-Maximization (EM) algorithm • Gaussian Mixture Models	
	8	R, 02/02	• Evaluation Metrics • **Final Project Discussion**	SA3
5. Non-parametric Learning	9	T, 02/07	• K-Means Clustering • Cluster Validity Metrics • K-Nearest Neighbors	
6. Discriminative Classification	10	R, 02/09	• Linear Discriminant Functions • Fisher's Linear Discriminant Analysis	HW2
	11	T, 02/14	• The Perceptron Algorithm • Logistic Discrimination	
	12	R, 02/16	• **Midterm Exam Review**	
Midterm Exam: Monday, February 27 @ 7:20 PM – 9:20 PM, covers modules 1-6 (Lect. # 1-12)				
7. Kernel Machine	13	T, 02/21	• Kernel Machines • Constrained Optimization with Lagrange Multipliers	
	14	R, 02/23	• Kernel Trick • Hard-Margin Support Vector Machine (SVM)	SA4 D3
	15	T, 02/28	• Slack Variables • Soft-Margin SVM	
8. Dimensionality Reduction	16	R, 03/02	• Feature Selection	
	17	T, 03/07	• Principal Component Analysis (PCA) • Kernel PCA	HW3
	18	R, 03/09	• Supervised vs Unsupervised Dimensionality Reduction • Applications of PCA and LDA	
Spring Break (March 11-18)				
9. Manifold Learning	19	T, 03/21	• Multi-Dimensional Scaling (MDS)	
	20	R, 03/23	• Isometric Feature Mapping (ISOMAP)	SA5
	21	T, 03/28	• Locally Linear Embedding (LLE)	D4
10. Artificial Neural Networks	22	R, 03/30	• Brief History of Artificial Neural Networks • Multi-Layer Perceptron (MLP) • Universal Approximation	SA6
	23	T, 04/04	• Backpropagation • Introduction to Keras with Tensorflow backend (tf.keras)	
	24	R, 04/06	• Best Practices for Training ANNs	HW4
11. Deep Learning	25	T, 04/11	• Deep Learning • Convolutional Neural Networks	

	26	R, 04/13	• Tensorflow implementations	
	27	T, 04/18	• Transfer Learning • Implementation and Examples	SA7
	28	R, 04/20	• Final Project Discussion	
	29	T, 04/25	• **Final Exam Review**	**Final Project**
Final Project: Wednesday, April 26 @ 11:59 PM Final Exam: Wednesday, May 3 @ 3:00 PM – 5:00 PM, covers modules 7-11 (Lect. # 13 -29)				

Attendance Policy, Class Expectations, and Make-Up Policy

Requirements for class attendance and make-up exams, assignments, and other work in this course are consistent with university policies. Click here to read the university attendance policies: https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/

Please carefully read the following 8 topics pertaining to class 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 the Canvas discussion boards. 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 collaboration and course etiquette.
(b) Questions about grades or personal issues may be emailed to me at catiaspsilva@ece.ufl.edu or within Canvas. You are welcome to use the telephone (352.392.6502), talk with me during office hours, or set up an appointment.
(c) We have a Slack page for the course: uf-ECE-FundML-spring2023.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 assignments 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, and participation, will happen during synchronous class meetings (including in an online setting, if any).

Expectations: I will prepare course materials 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 require code, clean, easy to read, easy to run, and well commented Python code is required.
(b) Individual assignments will not be graded on a curve. Final grades course grades will be graded on a curve.

Expectations: I will expect that students will 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.

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 in order 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 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 me 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 conflicts or time/date change requests.
Excused absences must be consistent with university policies in the undergraduate catalog (https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx) and require appropriate documentation.

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 assistants 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, particularly code, using 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	Percentage of Final Grade
Homework	100 each	15%
Participation	5 each	10%
Short assignments	10 each	15%
Midterm Exam	100	20%
Final Exam	100	20%
Final Project	100	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 access theoretical understanding; Part II – consists of practical problem/s to be implemented in Python.

- **Participation:** throughout the course I will ask for participation on a given topic in the form of class discussion boards. Participation points will be awarded for those posts/discussions and participation in class. Instructions on participation points will be discussed in the first lecture. The first participation points are awarded in week 1 and 2, so please keep an eye out for these.

- **Short Assignments:** 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, README file and technical report.

Note: This course is co-listed with the graduate section. The exams will involve additional questions for the graduate section with respect to the undergraduate section. Grading for the projects are different from the undergraduate course. The graduate and undergraduate sections will be graded separately, for which the graduate section has additional problems and different weights for all problems.

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

Students Requiring Accommodations
Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting https://disability.ufl.edu/students/get-started/. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

Course Evaluation
Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at https://gatorevals.aa.ufl.edu/students/. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via https://ufl.bluera.com/ufl/. Summaries of course evaluation results are available to students at https://gatorevals.aa.ufl.edu/public-results/.

In-Class Recording
Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A "class lecture" is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To "publish" means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

University Honesty Policy
UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code (https://sccr.dso.ufl.edu/process/student-conduct-code/) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Commitment to a Safe and Inclusive Learning Environment
The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:
• Your academic advisor or Graduate Program Coordinator
• Jennifer Nappo, Director of Human Resources, 352-392-0904, jpennacc@ufl.edu
• Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
• Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use
All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy
There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: https://registrar.ufl.edu/ferpa.html

Campus Resources:

Health and Wellness

U Matter, We Care:
Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: https://counseling.ufl.edu, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence
If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)
Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or http://www.police.ufl.edu/.

Academic Resources

E-learning technical suppor*t*, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. https://lss.at.ufl.edu/help.shtml.

Career Connections Center, Reitz Union, 392-1601. Career assistance and counseling; https://career.ufl.edu.

Library Support, http://cms.uflib.ufl.edu/ask. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. https://teachingcenter.ufl.edu/.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers. https://writing.ufl.edu/writing-studio/.

Student Complaints Campus*:* https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/;https://care.dso.ufl.edu.

On-Line Students Complaints*: https://distance.ufl.edu/state-authorization-status/#student-complaint*.