Applied Machine Learning Systems

EEL 4930
Class Periods: Tuesdays, period 7, 1:55 PM – 2:45 PM
Thursdays, period 7-8, 1:55 PM – 3:50 PM
Location: FAB 105
Academic Term: Fall 2023

Instructor:
Dr. Catia S. Silva
Email: catiaspsilva@ece.ufl.edu
Phone: (352) 392-6502
Office Location: NEB 467
Office Hours: Wednesdays 2pm-4pm, or by appointment
Slack: uf-eel5934-4930-f23.slack.com

Teaching Assistant (TA)/Undergraduate Peer Instructor (UPI):
Name: Spencer Chang, TA
Office Hours: Tuesdays 10am-12pm

Name: Bradley Johnson, UPI
Office Hours: Thursdays 6pm-7:30pm, Fridays 6pm-7:30pm

Course Description

(3 credits) This course aims to provide a framework to develop real-world machine learning systems that are deployed, reliable, and scalable. It covers introductory topics in machine learning systems and the use of these systems in a variety of real-world applications. The focus of this course is to introduce students to basic machine learning concepts and how to use associated state-of-the-art machine learning tools.

Course Pre-Requisites / Co-Requisites

Students are expected to have the following background:

- Knowledge of basic programming (Python preferred)
- Knowledge of basic probability theory and statistics
- Knowledge of basic linear algebra
- Other: Students are expected to bring a portable computer to class meetings

Course Objectives

Upon completion of this course, students will be able to:

- Utilize terminology for Artificial Intelligence (AI), Machine Learning (ML) and Deep Learning (DL) tools.
- Design and conduct meaningful experiments to evaluate the performance of ML models.
- Determine which ML model to use for an application and/or task.
- Identify and explain strengths and limitations of ML models.
- Select appropriate metrics of success.
- Implement in code several ML models utilizing state-of-the-art off-the-shelf libraries.

Materials and Supply Fees

None

Required Textbooks and Software

- Software:
    - Python 3+
    - Git
    - TensorFlow

- Anaconda (recommended)

The course notes are developed by the instructor.

Recommended Materials

- Hands-On Machine Learning with Scikit-Learn, Keras and Tensorflow
  - Aurélien Géron
  - 2nd edition
  - O'Reilly Media, 2019
  - ISBN: 978-1-492-03264-9

- Python Machine Learning – Machine Learning and Deep Learning with Python, scikit-learn, and Tensorflow 2
  - Sebastian Raschka and Vahid Mirjalili
  - 3rd edition
  - Packt Publishing Ltd., 2019
  - ISBN: 978-1-78995-575-0

- All reading materials will be available as physical and electronic copies with Course Reserves

Course Schedule

Module	Lecture	Day	Topic/s	Assignments
1. Introduction to Machine Learning	1	R, 08/24	• What is Machine Learning? • Types of learning • Introduction to Git and GitHub	Meet & Greet
	2	T, 08/29	• Introduction to Jupyter Notebooks • Introduction to Python: NumPy, Matplotlib, Pandas, Scikit-Learn	
2. Data Preprocessing & Experimental Design	3	R, 08/31	• **HiPerGator Session** • Introduction to supervised learning for regression tasks • Linear regression	HW0 Assign
	4	T, 09/05	• Building scikit-learn pipeline • Data Encoding and data cleaning	
	5	R, 09/07	• Hyperparameter Tuning & Sampling Strategies (cross-validation, nested CV, stratified CV, Bootstrap)	HW0 Due
	6	T, 09/12	• Introduction to supervised learning for classification tasks • Logistic regression	Project 1 Assign: Building & Evaluating Classifiers
	7	R, 09/14	• Model Selection and Performance Metrics (hypothesis testing, confidence intervals, ROC, F1, etc.)	HW1 Assign
	8	T, 09/19	• Regularization • Scikit-learn pipelines	
3. Introduction to Supervised Classification	9	R, 09/21	• Decision Trees • Random Forests	HW1 Due
	10	T, 09/26	• Bagging and Boosting	HW2 Assign
	11	R, 09/28	• Gradient Boosting Machines (GBM)	

	12	T, 10/03	• Hard-Margin Support Vector Machines • Slack Variables	HW2 Due
	13	R, 10/05	• Soft-Margin Support Vector Machines	
	14	T, 10/10	• Midterm Exam Review	Project 1 Due (10/11)
Midterm Exam: Monday, October 17 @ 7:20 PM – 9:20 PM (covers lectures 1-14)				
4. Introduction to Dimensionality Reduction	15	R, 10/12	• The Curse of Dimensionality • Principal Component Analysis (PCA)	Project 2 Assign: Unsupervised Learning
	16	T, 10/17	• Manifold Learning with LLE and t-SNE	
	17	R, 10/19	• Code implementations	HW3 Assign
5. Introduction to Non-Parametric Learning	18	T, 10/24	• K-Means Clustering • DBSCAN	
	19	R, 10/26	• Hierarchical clustering • Clustering Validity Measures	HW3 Due
	20	T, 10/31	• K-Nearest Neighbors	
6. Introduction to Deep Learning	21	R, 11/02	• Introduction to Tensorflow	Project 2 Due (11/03)
	22	T, 11/07	• Artificial Neural Networks	Project 3 Assign: Neural Networks
	23	R, 11/09	• Gradient Descent • Backpropagation	
	24	T, 11/14	• Convolutional Neural Networks	HW4 Assign
	25	R, 11/16	• Auto-Encoders	
	26	T, 11/21	• Generative Adversarial Networks (GANs)	HW4 Due
Thanksgiving (November 23-26)				
7. Explainable & Fair AI	27	T, 11/28	• Explainable Deep Learning with LIME	HW5 Assign
	28	R, 11/30	• Fairness in Deep Learning with aifair360	
	29	T, 12/05	• Final Exam Review	HW5 Due Project 3 Due (12/06)
Final Exam: Wednesday, December 13 @ 3:00 PM – 5:00 PM (covers lecture 15-29)				

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-eel5934-4930-f23.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%
Project 1	100	15%
Project 2	100	15%
Project 3	100	15%
Midterm Exam (1)	100	20%
Final Exam (1)	100	20%
		100%

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 access theoretical understanding; Part II – consists of practical problem/s to be implemented in Python.

- **Exams:** (1) The exams will be drawn evenly from all lectures, assignments, and readings that occurred up to that point in the course. The content to be covered in the exams are listed in the schedule above. None of the exams will cover any other topics outside of the ones listed, although some concepts are in nature cumulative. (2) Exams will have 2 parts: Part I – theoretical questions to be solved on paper; part II – simulation questions to be solved using Python and Jupyter Notebooks.

- **Projects:** Each project will be based on concepts covered in class (see schedule above). All projects are individual assignments. For each project, students are expected to write a report, submit their code and create a written demo (README file) on how to use their code. The code should be pushed to a GitHub repository in a form that can be cloned and run readily.

Note: This course is co-listed with the graduate class. The homework portion of the graduate section will involve additional work and more advanced concepts with respect to the undergraduate section. Grading for the homework and project 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*.