Introduction to Machine Learning
EEE 3773 Section 19275
Class Periods: Tuesdays and Thursdays, period 5-6, 2:00 PM – 4:45 PM
Location: NEB 101
Academic Term: Summer C 2022

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Office Hours: Wednesdays 3:30 PM – 6:00 PM
Slack: uf-eee3773-summer2022.slack.com

Course Description
(4 credits) This course will cover introductory topics in pattern recognition and machine learning and use of these methods towards a variety of real-world applications. The focus of this course is to introduce basic machine learning concepts and learn how to use associated state-of-the-art machine learning tools. Topics covered include deep learning, linear and non-linear classifiers.

Course Pre-Requisites / Co-Requisites
- EEL 3135 (Introduction to Signals & Systems) or equivalent

Course Objectives
Understand and use the concepts of machine learning for data science. Focus on tools for application of deep learning and multivariate data analysis to real world data and problems.
These objectives will be accomplished through:
1. Semester-long group project that involves implementing a deep learning system
2. Discussion of pattern recognition and machine learning methods
3. Implementation of a variety of machine learning methods in code in assignments and lab activities

Materials and Supply Fees:
None

Professional Component (ABET):
This course consists of 1.5 credits of Engineering Design and 1.5 credits of Engineering Science

Relation to Program Outcomes (ABET):

Outcome	Coverage*
1. An ability to identify, formulate, and solve engineering problems by applying principles of engineering, science, and mathematics.	High
2. An ability to apply both analysis and synthesis in the engineering design process, resulting in designs that meet desired needs.	High
3. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.	High
4. An ability to communicate effectively with a range of audiences	

5. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.	
6. An ability to recognize the ongoing need for additional knowledge and locate, evaluate, integrate, and apply this knowledge appropriately.	
7. An ability to function effectively on teams that establish goals, plan tasks, meet deadlines, and analyze risk and uncertainty	

Required Textbooks and Software

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

   Please see the computer requirements for minimum hardware requirements.

2. **Required Textbooks:**
   - **Python Machine Learning**
     - Sebastian Raschka and Vahid Mirjalili
     - 2nd edition
     - Packt Publishing, 2017
     - ISBN: 978-1-78712-602-2

   This book is freely available via Course Reserves (you can easily access it under the "Course Reserves" tab in our Canvas page) as an electronic copy and at the library.

Recommended Materials
   - **Hands-On Machine Learning with Scikit-Learn, Keras, and Tensorflow**
     - Aurélien Géron
     - 2nd edition
     - O'Reilly Media, 2019
     - ISBN: 978-1-492-03261-8

   This book is freely available via Course Reserves (you can easily access it under the "Course Reserves" tab in our Canvas page) as an electronic copy and at the library.

All textbooks are listed and available online through Course Reserves. You can 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	T, 05/10	• What is Machine Learning? • Types of learning • Introduction to Git and GitHub	HW 0

	2	R, 05/12	• Introduction to Jupyter Notebooks • Introduction to Python: NumPy, Matplotlib, Pandas, Scikit-Learn	HW 1
1. Introduction to Machine Learning	3	T, 05/17	• Linear Regression • Overfitting and Underfitting • Regularization • Model Selection; Occam's Razor	
	4	R, 05/19	• **HiperGator Help Session** • Experimental Design • Hyperparameter tuning; Cross-validation	HW2
	5	T, 05/24	• Error and Accuracy Metrics • ROC curves • **Project discussion**	
	6	R, 05/26	• **Lab 1**	Lab 1
2. Introduction to Supervised Classification	7	T, 05/31	• The Curse of Dimensionality • Feature Selection & Feature Engineering	
	8	R, 06/02	• Principal Component Analysis (PCA) • Fisher's Linear Discriminant Analysis (LDA)	HW3
	9	T, 06/07	• K-Nearest Neighbors (k-NN) • Weighted k-NN	
	10	R, 06/09	• Decision Trees • Random Forests	HW4
	11	T, 06/14	• Support Vector Machines (SVM)	
	12	R, 06/16	• Midterm Exam Review • **Lab 2**	Lab 2
Summer Break (June 20 – June 24)				
Midterm Exam: Monday, June 27 @ 7:00 PM – 9:00 PM, covers modules 1-2 (Lect. # 1-12)				
3. Introduction to Neural Networks	13	T, 06/28	• Brief History of Artificial Neural Networks (ANNs) • The Perceptron algorithm	
	14	R, 06/30	• Multi-Layer Perceptron (MLP) • The Universal Approximation Theorem	HW5
	15	T, 07/05	• Backpropagation	
	16	R, 07/07	• Best Practices for Training ANNs	HW6
	17	T, 07/12	• Introduction to PyTorch, Tensorflow and TensorBoard • **Lab 3**	Lab 3
4. Introduction to Deep Learning	18	R, 07/14	• Introduction to Deep Learning • Convolutional Neural Networks (CNNs)	
	19	T, 07/19	• Applications and Implementations	HW7
	20	R, 07/21	• Auto-Encoders • Generative Adversarial Networks (GANs)	

	21	T, 07/26	• Project Discussion • **Lab 4**	Lab 4
5. Project Discussion	22	R, 07/28	• In-Class Project Development	
	23	T, 08/02	• **Final Exam Review** • In-Class Project Development	Final Project
	24	R, 08/04	• In-Class Project Wrap Up • Final Project Presentations	Project Presentations

Final Project: Tuesday, August 2 @ 11:59 PM
Project Presentations: Thursday, August 5 @ 3:30 PM
Final Exam: Friday, August 5 @ 7:00 PM – 9:00 PM, covers modules 3-4 (Lect. # 13-20)

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-eee3773-summer2022.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 (8)	100 each	30%
Lab Assignments (4)	100 each	20%
Semester-long Project (1)	100	10%
Midterm Exam (1)	100	20%
Final Exam (1)	100	20%
	TOTAL	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.

- **Lab 1 (5%):** The objective of Lab 1 is to introduce students to the experimental design process for machine learning. Students will develop a project proposal that includes identification of a data set with discussion as to whether the data is easily available, the amount of data available, whether ground truth is available or can be generated. The proposal will also discuss a set of appropriate error metrics for the proposed project, methods for cross-validation and blind test set generation appropriate for the proposed problem, a set of experiments to be conducted and the proposed experimental design.

- **Lab 2 (5%):** The objective of Lab 2 is to introduce the students to the importance of pre-processing, normalization, feature extraction and feature selection. Students will develop, implement and compare several pre-processing pipelines on their approved project data sets. Students will also implement feature visualization scripts and cluster validity-type metrics to aid in their pre-processing evaluation and visualization.

- **Lab 3 (5%):** The objective in Lab 3 is to compile an initial end-to-end machine learning pipeline for provided data sets that include pre-processing, classification and evaluation on their approved project data sets. Students will compare classifiers implemented and provide discussion as to why some out-perform others given the properties of their data set and the classifiers used.

- **Lab 4 (5%):** The objective of Lab 4 is to finalize their choice of pre-processing pipeline and classifier selection, provide discussion and motivation for their chosen approach based on outcomes from Labs 1-3 and any additional experiments required

- **Final Project (10%):** In their final project, students will carry out their full experimental design, run and evaluate their performance on a hold-out blind test set, provide extensive comparisons and discussions to alternative approaches, and present their work to the class. The deliverables of the final project include: push code to a GitHub repository with an elaborate READ-ME file, technical report in IEEE format and PowerPoint presentation.

- **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. You are responsible for all assigned material.

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 Conduct 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. 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

Covid-19 Protocols:
• You are expected to wear approved face coverings at all times during class and within buildings even if you are vaccinated. Please continue to follow healthy habits, including best practices like frequent hand washing. Following these practices is our responsibility as Gators.

• If you are sick, stay home and self-quarantine. Please visit the UF Health Screen, Test & Protect website about next steps, retake the questionnaire and schedule your test for no sooner than 24 hours after your symptoms began. Please call your primary care provider if you are ill and need immediate care or the UF Student Health Care Center at 352-392-1161 (or email covid@shcc.ufl.edu) to be evaluated for testing and to receive further instructions about returning to campus. UF Health Screen, Test & Protect offers guidance when you are sick, have been exposed to someone who has tested positive or have tested positive yourself. Visit the UF Health Screen, Test & Protect website for more information.

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 Resource 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*:* http://www.distance.ufl.edu/student-complaint-process.