Fundamentals of Machine Learning
EEL 5840   Section 0001
Class Periods: MWF, period 5, 11:45 AM – 12:35 PM
Location: Online via synchronous Zoom meetings
Academic Term: Spring 2021

Instructor: Dr. Catia S. Silva
catiaspsilva@ece.ufl.edu
(352) 392-6502
Office Hours: Mondays and Wednesdays 3:00 PM – 4:00 PM, Thursdays 11:45 AM – 12:35 PM

Course Description
Engineering and hardware concepts pertaining to design of intelligent computer systems.

Course Pre-Requisites / Co-Requisites
None

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 handle uncertain data with probability models.

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

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** *(ML)* ✳
     - Christopher Bishop
     - Springer, 2006
     - ISBN: 978-0-38731-073-2
   The digital pdf is freely available and is perfectly fine for this course.

Recommended Materials

- **Introduction to Machine Learning** *(IML)*
  - o Ethem Alpaydin
  - o 3rd edition
  - o The MIT Press, 2014
  - o 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)

- **Deep Learning** *(DL)*
  - o Ian GoodFellow, Yoshua Bengio and Aaron Courville
  - o MIT Press, 2016
  - o ISBN: 978-0-262-03561-3

  The online book is freely available online and is perfectly fine for this course.

- **Python Data Science Handbook – Essential Tools for Working with Data** *(PDS)*
  - o Jake VanderPlas
  - o O'Reilly Media, 2016
  - o ISBN: 978-1-491-91205-8

  The online book is freely available and is perfectly fine for this course

- **Python Machine Learning** *(PML)*
  - o Sebastian Raschka and Vahid Mirjalili
  - o 2nd edition
  - o Packt Publishing, 2017
  - o ISBN: 978-1-787-12602-2

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

- **A Whirlwind Tour of Python** *(WP)*
  - o Jake VanderPlas
  - o O'Reilly Media, 2016
  - o ISBN: 978-1-491-96465-1

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
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.

Video: refers to short (< 20 min) recordings to watch as a preparation or supplement of lecture				
Module	**L. #**	**Day**	**Topic/s**	**Reading Materials**
1. Introduction to Machine Learning	1	M, 01/11	- What is Machine Learning? - Introduction to Git and Jupyter Notebooks **(video)** Introduction to Python: NumPy, Matplotlib, Pandas	**Install:** git, GitHub Desktop, Python, Anaconda, nbextensions **DL:** C-1 **WP**: S-3, S-4, S-5 **PDS:** C-1, C-2, C-3, C-4

	2	W, 01/13	• Types of learning • Introduction to Supervised Learning	**PML:** C-1 **IML:** C-1, C-2
	3	F, 01/15	• (Linear) Regression	**ML:** S-1.1 **PDS:** S-5.6
	--	M, 01/18	Martin Luther King Jr. Day	
2. Experimental Design and Analysis	4	W, 01/20	• Model selection; Occam's Razor • Generalization	**ML:** S-1.3 **IML:** S-2.7 **PDS:** S-5.3
	5	F, 01/22	• The Curse of Dimensionality	**ML:** S-1.4
	6	M, 01/25	• The No Free Lunch Theorem • Regularization	**IML:** S-19.1
	7	W, 01/27	• Linear Basis Functions • The Bias-Variance Trade-Off	**ML:** S-3.1, S-3.2, S-3.6 **DL:** S-5.4
	8	F, 01/29	• Experimental Design • Hyperparameter tuning; Cross-validation	**IML:** S-19.2 – S-19.6
3. Bayesian Learning	9	M, 02/01	• Maximum Likelihood Estimation (MLE)	**ML:** C-2, S-3.3 **DL:** S-5.5
	10	W, 02/03	• Maximum A Posteriori (MAP)	**ML:** S-3.4 **DL:** S-5.6
	11	F, 02/05	• Bayesian Prior Equivalence	**ML:** S-3.5 **IML:** C-3, S-4.1, S-4.2, S-4.3, S-4.4
4. Generative Classification	12	M, 02/08	• Introduction to Classification • Probabilistic Generative Models	**DL:** S-5.7
	13	W, 02/10	• Naïve Bayes Classifier	**ML:** S-4.2 **IML:** S-4.5, S-4.6, S-4.7, S-4.8
	14	F, 02/12	• Mixture Models • Expectation-Maximization (EM) Algorithm	**ML:** S-2.3.9, S-9.2
	15	M, 02/15	• Gaussian Mixture Models	**ML:** S-9.3, S-9.4 **PDS:** S-5.12
	16	W, 02/17	• Evaluation Metrics	**IML:** S-19.7 – S-19.14
–	17	F, 02/19	Final Project Discussion	
	18	M, 02/22	Midterm Exam Review	

	19	W, 02/24	• Hipergator help session	📡 **Connect to:** [jhub](), [help & documentation]() 🖥 **Complete (mandatory):** [Hipergator account training]()
			Covers modules 1-4 (Lect. # 1-18) **Midterm Exam (tentative): Thursday, February 25, 2021 @ 4:00 PM – 6:00 PM**	
5. Non-parametric Learning	20	F, 02/26	• Clustering • K-Means Clustering	✳ **ML:** [S-9.1]() 🖳 **PDS:** [S-5.11]()
	21	M, 03/01	• Cluster Validity Metrics	⚙ **PML:** C-11
	22	W, 03/03	• K-Nearest Neighbors	✳ **ML:** [S-2.5]() 🧠 **IML:** S-8.1 – S.8.5
6. Discriminative Classification	23	F, 03/05	• Discriminant Functions	✳ **ML:** [S-4.1]() 🧠 **IML:** S-10.1, S-10.2
	24	M, 03/08	• Linear Discriminant Functions	✳ **ML:** [S-4.1]() 🧠 **IML:** S-10.3 – S-10.5
	25	W, 03/10	• The Perceptron Algorithm	✳ **ML:** [S-4.1]() 🧠 **IML:** S-10.6
	26	F, 03/12	• Logistic Discrimination	🧠 **IML:** S-10.7, S-10.8
7. Kernel Machine	27	M, 03/15	• Kernel Machine • Lagrange Multipliers	✳ **ML:** [Appendix E]() 🧠 **IML:** S-13.1
	28	W, 03/17	• Support Vector Machine (SVM)	✳ **ML:** [S-7.1]() 🧠 **IML:** S-13.2, S-13.3
	29	F, 03/19	• Kernel trick • Slack variables	🧠 **IML:** S-13.4 – S-13.9 🖳 **PDS:** [S-5.7]()
8. Dimensionality Reduction and Manifold Learning	30	M, 03/22	• Dimensionality Reduction • Feature Selection	🧠 **IML:** S-6.1, S-6.2
	31	W, 03/24	• Principal Component Analysis (PCA)	✳ **ML:** [S-12.1]() 🧠 **IML:** S-6.3 🖳 **PDS:** [S-5.9]()
	32	F, 03/26	• Supervised vs Unsupervised Dimensionality Reduction • Kernel PCA	🧠 **IML:** S-6.6 ⚙ **PML:** C-5
	33	M, 03/29	• Manifold Learning • Multi-Dimensional Scaling (MDS)	🧠 **IML:** S-6.5
	34	W, 03/31	• Isometric feature mapping (ISOMAP)	🧠 **IML:** S-6.7

	35	F, 04/02	• Locally Linear Embedding (LLE)	**IML:** S-6.8 **PDS:** S-5.10
9. Neural Networks	36	M, 04/05	• Artificial Neural Networks: brief history	**ML:** S-5.1 **IML:** S-11.1
	37	W, 04/07	• Multi-Layer Perceptron (MLP) • Universal Approximation	**ML:** S-5.2 **IML:** S-11.2 – S-11.6
	38	F, 04/09	• Backpropagation	**ML:** S-5.3 **IML:** S-11.7
	39	M, 04/12	• Training procedures	**IML:** S-11.8 – S-11.11
	40	W, 04/14	• Combining Multiple Learners • Bagging and Boosting	**ML:** C-14 **IML:** C-17
10. Deep Learning	41	F, 04/16	• Deep Learning • Convolutional Neural Networks	**DL:** C-9 **PML:** C-7
	42	M, 04/19	• Transfer Learning • Project discussion	**DL:** C-9
–	43	W, 04/21	Final Exam Review	

Covers modules 5-10 (Lect. # 20-43)
Final Exam (scheduled): Friday, April 30, 2021 @ 7:30 AM – 9:30 AM

Online Course Recording
Our class sessions may be audio visually recorded for students in the class to refer back and for enrolled students who are unable to attend live. Students who participate with their camera engaged or utilize a profile image are agreeing to have their video or image recorded. If you are unwilling to consent to have your profile or video image recorded, be sure to keep your camera off and do not use a profile image. Likewise, students who un-mute during class and participate orally are agreeing to have their voices recorded. If you are not willing to consent to have your voice recorded during class, you will need to keep your mute button activated and communicate exclusively using the "chat" feature, which allows students to type questions and comments live. The chat will not be recorded or shared. As in all courses, unauthorized recording and unauthorized sharing of recorded materials is prohibited.

Attendance Policy, Class Expectations, and Make-Up Policy

This class will be presented online using Zoom and requires access to a working webcam and stable internet connection. I prefer that students keep their camera on during the class so that I can see you as I would during normal face-to-face classes. Studies show that if we can see each other's faces then we will have more engagement, more student success, and more faculty success. However, this is not a requirement. I understand if on certain days you can't have your camera on due to internet bandwidth limitations, other family members, health issues, or any other reasons.

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 – this will protect your [FERPA rights](). 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: https://uf-eel5840-spring2021.slack.com/. This is an optional resource for students to discuss the course amongst each other and occasionally 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. Please review the classroom etiquette guidelines at the end of this section.

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 class.

Expectations: I will prepare course materials with the expectation that students will attend class 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 3.4.3+ 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.

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 students will communicate with me about any requests and conflicts well in advance of any assignment. Excused absences must be in compliance with university policies in the Graduate Catalog (http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#attendance) 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	20%
Participation	5 each	10%
Short assignments	10 each	10%
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 typically consist of algorithm implementation and result analysis assigned at the end of class. These assignments have a shorter timeframe for completion than a typical homework.

- **Exams:** (1) will be conducted via Honorlock. (2) The exams will be drawn evenly from all lectures, assignments, and readings that occurred up to that point in the course. The final exam is drawn from material since the Midterm. The 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 a report.

Online Proctoring with Honorlock

Your exams this semester will be proctored by Honorlock. Honorlock is an online proctoring service that allows you to take your exam from the comfort of your home. Honorlock is available 24/7 all you need is a computer, webcam, and a stable internet connection. You DO NOT need to create an account, download software or schedule a proctoring appointment.

Once a quiz has been published to Canvas, all you need to do is log into Canvas and click on the quiz you need to take. You will be prompted to add the Honorlock Chrome Extension, which is required to take your exam. You are required to use Google Chrome as your browser. Then you will need to take a picture, show your ID, and scan your room. Honorlock will be recording you via webcam and they will be recording your screen. They also have integrity algorithm that can detect search-engine use, so do not attempt to cheat or look up answers, even if its secondary device.

Please read the Student Exam Preparation information document carefully as it provides information about any expectations and requirements to use Honorlock.

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

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/.

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/policies/student-honor-code-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
• Robin Bielling, Director of Human Resources, 352-392-0903, rbielling@eng.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: http://www.counseling.ufl.edu/cwc, 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://www.crc.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://care.dso.ufl.edu.

On-Line Students Complaints*:* http://www.distance.ufl.edu/student-complaint-process.