EMA 6938 – Machine Learning and Data Science for Materials

Course Syllabus – Fall 2021

	Office	Email
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Course Description (3 credit hours)

Special Topics in Materials Science and Engineering.

Prerequisites:

No prerequisite. Knowledge of vector and matrix algebra, derivatives and integrals, probabilities and random variables statistics, and some experience in coding in any language, such as Python (preferred), MATLAB, Java, C.

Course Objectives

In this course, you will learn the mathematical fundamentals of data science and machine learning, gain hands-on experience developing software using Python and data science tools, and apply modeling techniques to materials and processes to solve real-world engineering problems.

Class Time (Attendance of at least two class periods per week is recommended)

Monday, Wednesday	On-Campus students	Period 2	9:35 am - 10:25 pm
Thursday	EDGE students	Double Period	6:00 pm - 7:30 pm

Classes will take place on Zoom at https://ufl.zoom.us/j/91396193150 and in CSE E107.

Textbook: (recommended)

Title: Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow.
Author: Aurélien Géron
ISBN: 1492032646

Supplementary reading and links to various other resources/websites are provided and updated throughout the semester.

Course Website

The course website is on the Canvas system https://ufl.instructure.com, where you can find the announcements, syllabus, pre-recorded video lectures, lecture notes, and homework assignments. We will also use Canvas for preparatory quizzes, the course exams, and your grades. Please check it frequently.

Flipped Classroom Model

The course will utilize a flipped classroom model. A flipped classroom is a teaching approach where you will first explore new content outside the class by viewing a **pre-recorded video lecture** and completing a **preparatory quiz** on Canvas.

Our regularly scheduled online class time is organized around student engagement, inquiry, and assessment, allowing us to elaborate on machine learning and data science concepts and apply them to materials problems. The in-class sessions will typically entail structured discussions of Jupyter Notebooks, collaborative problem solving, and case studies. The in-class session will also be recorded and posted on Canvas.

Flipped classroom improved the student performance and learning experience effectively (see for example https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6852382/). To take advantage of the in-class discussion and problem solving requires everyone to watch the video lecture before the in-class activity and complete the quiz. Active participation and engagement in class will help you understand the material and acquire the skills to utilize machine learning and data science tools to solve materials problems you will encounter throughout your career. I expect attendance. Questions are highly encouraged. If you do not understand something, the chances are that your classmates have missed that point too. You are responsible for material presented in lectures, reading assignments, homework, and distributed notes.

Homework

Two homework exercises will be assigned. These homework questions are essential to your study and prepare you for the exams. Some exam questions will be adapted from homework. Homework is usually due back a week before the corresponding exam. The approximate homework due dates are February 10 and April 7. The exact submission dates will be posted in the e-learning assignments. The purpose of homework is to allow you to evaluate and apply your knowledge. You may collaborate on homework; however, the submitted assignment must represent your own work and preparation. Please ask during the online class to discuss homework problems.

Homework submission is electronic on Canvas and must be in the form of a Jupyter Notebook and a pdf printout. Email is not acceptable for the submission of homework. Hard copies are also not accepted.

Homework will be evaluated on the following basis:

	100	85	70	0
Completion	All assigned work is complete.	Most assigned work is complete.	Some assigned work is complete.	Assignment not complete.
Accuracy	All answers are correct.	Most answers are correct.	Some answers are correct.	Little to no answers are correct.
Work shown (derivations and figures)	All work shown in detail.	Most work shown in detail.	Several steps or figures missing.	Did not show any work.

No credit will be given for late unexcused submissions.

Quizzes and Interactive Learning

We will have online preparatory quizzes covering current and recent lecture material. The quizzes will typically consist of ten questions that should take about 20 minutes to answer. The quizzes serve as feedback for you and me that you understood the pre-recorded video lectures.

Exams

We will have two exams. The exams will consist of concept questions to evaluate your familiarity with the course content. The exams will be open book and provide ample time to answer the questions. The exams will be on Canvas and use HonorLock. Exam work must be individual and collaboration is never allowed. Observations of cheating will be promptly reported to Academic Advising. Please see UF's statement on academic honesty: https://www.dso.ufl.edu/%20sccr/process/student-conduct-honor-code.

There is no final exam in this class. Exam dates are tentatively scheduled for:

Exam 1: February 17, 2021
Exam 2: April 7, 2021

Exam Conflicts with other course exams

The official UF policy on exam conflict resolution states that when two exams conflict, the course with the higher number will take priority.

Make-up exams

Make up exams will be provided only with the ***prior approval of the instructor.*** Excused absences must be consistent with university policies in the Graduate Catalog (https://catalog.ufl.edu/graduate/regulations) and require appropriate documentation. Additional information can be found here: https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/. In general, acceptable reasons for excused absence from an exam include illness, serious family emergencies, special curricular requirements, military obligation, court-imposed legal obligations, and religious holidays. In all cases, you will be required to provide written documentation, and obtain prior instructor approval. You will not be excused from any exam without following the policy above, with no exceptions. Students not in attendance for the scheduled exam will receive a score of zero. **You must notify the instructor no less than 1 week of the scheduled exam of your intent and justification for missing the exam.** Make-up exams for excused absences as well as exam conflicts must occur within 1 week of the missed exam, and may occur before the missed exam.

Grading

Grades will be based on your understanding and mastery of the material as demonstrated by the exams, preparatory quizzes, and homeworks.

Preparatory Online quizzes	10%
Homework sets (2)	30%
2 midterm exams	30%
Project Jupyter Notebook and Presentation	30%

You have two weeks after the test results are posted to resolve any questions about scores and grades. No changes to your exam grade will be made after that time.

Grading Scale

This course follows current UF grading policies for assigning grade points

Percentage	≥92	≥88	≥84	≥80	≥76	≥72	≥68	≥65	≥62	≥59	≥56	<56
Letter Grade	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	E
Grade Points	4.0	3.67	3.33	3.0	2.67	2.33	2.0	1.67	1.33	1.0	0.67	0

In order to graduate, graduate students must have an overall GPA and an upper-division GPA of 3.0 or better (B or better). Note: a B- average is equivalent to a GPA of 2.67, and therefore, it does not satisfy this graduation requirement.

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/.

Online Course Recording

Our class sessions will 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.

Record keeping

All materials from this class that students did not pick up (graded exams, etc.) within 1 year of the end of class will be shredded on or after May 15, 2023.

Syllabus Changes

I reserve the right to make changes in the syllabus as needed. Any changes will be clearly announced on canvas and in class.

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, Assoc. Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Assoc. 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. Accommodation for Students with Disabilities

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.

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/.

COVID-19: You are expected to wear approved face coverings at all times during class and within buildings even if you are vaccinated. 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.

If you are withheld from campus by the Department of Health through Screen, Test & Protect, you are not permitted to use any on campus facilities. Students attempting to attend campus activities when withheld from campus will be referred to the Dean of Students Office.

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.

Please continue to follow healthy habits, including best practices like frequent hand washing. Following these practices is our responsibility as Gators.

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.

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

Week	Class dates	Topics
1	January 6	Introduction
2	January 11 January 13	Programming Tools: Introduction to Python Math Review: Probability and Statistics
3	January 18 January 20	Math Review: Linear Algebra and Differential Calculus Data Science Tools: Materials Databases and Pandas Data Frames
4	January 25 January 27	Univariate and Multivariate Linear Regression Polynomial Regression
5	February 1 February 3	Cross Validation and Regularization
6	February 8 February 10	Kernel Trick: Kernel Ridge Regression and Support Vector Machines
Homework 1 due on February 10		
7	February 15	Question and Answer Session for Midterm and Project Ideas
Midterm Exam 1 on February 17		
8	February 22 February 24	Tree-Based Methods: Regression and Classification Tress
Project Proposal Due March 1		
9	March 3	Random Forest, and Gradient Boosted Trees
10		Spring Break
11	March 15 March 17	Unsupervised Learning: PCA and K-Means Clustering
12	March 22 March 24	Project Work Week
13	March 29 March 31	Deep Neural Network: Multilayer perceptron Convolutional and Recurrent Neural Network
Homework 2 due on March 31		
14	April 5	Question and Answer Session for Midterm and Projects
Midterm Exam 2 on April 7		
15	April 12 April 14	Project Presentations
Project Reports and Notebooks due on April 17		