

Data Science for ECE
EEL 3850
Class Periods: TR 7-8 (1:55pm – 3:50pm)
Location: LIT 0237
Academic Term: Fall 2022

Instructor:

Shreya Saxena
shreya.saxena@ufl.edu
(352)-392-2651
Office Hours (Saxena): TR 3:50pm – 4:40pm
Office Hours (Hellwege): MW 6 (12:50pm-1:40pm) NEB
Office Hours (Santiago): MW 5 (11:45am-12:35pm) NEB

Teaching Assistant/Peer Mentor/Supervised Teaching Student:

Conrad Hellwege
conrad.hellwege@ufl.edu

Course Description

(4 credits) Analysis, processing, simulation, and reasoning of data. Includes data conditioning and plotting, linear algebra, statistical methods, probability, simulation, and experimental design.

Course Pre-Requisites / Co-Requisites

- MAC 2312 (Calculus 2)
- EEL 3834 (Programming I)
- Other: Students are expected to bring a portable computer to class meetings

Course Objectives

Upon completion of this course, the student will be able to:

1. Implement, debug, and deploy Python code
2. Generate visualizations to expose meaning in data
3. Generate and understand the meaning and uses of summary statistics of data
4. Model random phenomena using random variables
5. Generate random variables with specified densities or distributions
6. Conduct hypothesis tests using simulations and analysis
7. Understand and use conditioning to simplify problems
8. Estimate parameters of distributions from samples
9. Understand dependence and independence among random phenomena
10. Use statistical tests to determine or characterize dependence among random phenomena
11. Design experiments to understand random phenomena
12. Understand the difference between Bayesian statistics and classical statistics
13. Use simulation to calculate Bayesian statistics
14. Apply linear algebra for data processing and statistical calculations

Materials and Supply Fees: None

Professional Component (ABET):

This course consists of 4 credits of Engineering Science.

Relation to Program Outcomes (ABET):

Outcome	Coverage*
---------	-----------

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	High
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	High
3. An ability to communicate effectively with a range of audiences	High
4. 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	
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	

*Coverage is given as high, medium, or low. An empty box indicates that this outcome is not covered or assessed in the course.

Required Software:

- A computer with the following software installed:
 - [Python 3.4.3 or later](#)
 - [Anaconda Distribution](#)
 - [Git](#)
 - [GitHub Desktop](#) (recommended for beginners)

Please see the College of Engineering [computer requirements](#) for minimum hardware requirements and specifications.

Required Textbooks:

All textbooks are listed and available as both a physical and electronic version through UF Libraries "Course Reserves". You can find a list of all materials in our Canvas page under the "Course Reserves" icon.

- **Introduction to Probability**
 - Authors: Dimitri P. Bertsekas, John N. Tsitsiklis
 - 2nd edition
 - Athena Scientific, 2008
 - ISBN: 978-1-886529-23-6
 - The [digital pdf version](#) is freely available and is perfectly fine for this course
- **Introduction to Applied Linear Algebra – Vectors, Matrices, and Least Squares**
 - Author: Stephen Boyd
 - Cambridge University Press, 2018
 - ISBN: 978-1-316518-96-0
 - The [digital pdf version](#) is freely available and is perfectly fine for this course

Recommended Materials

- **Foundations of Data Science with Python**

- Author: John M. Shea
- This book is best read online. The [online version](#) is freely available and is perfectly fine for this course.

Course Schedule

Module	Day \ Date	Lecture	Topics
1. Introduction to Data Science and Python	R 08/25	1	<ul style="list-style-type: none"> • What is Data Science? • Introduction to Git and Jupyter Notebooks • Introduction to Python, NumPy, Matplotlib • First Simulations
2. Introduction to Probability	T 08/30	2	<ul style="list-style-type: none"> • (video) Introduction to functions in Python • Fair experiments and simulations • Relative frequency and probability • (video) Random experiments, sample spaces, and set operations • Probabilistic models
	R 09/01	3	<ul style="list-style-type: none"> • Conditional probability • Statistical independence • Total probability • Applications: binary communication channel, error probabilities, Monty Hall problem
	T 09/06	4	<ul style="list-style-type: none"> • Bayes' Rule • Frequentist vs. Bayesian probability • Combinatorics, counting
3. Exploratory Data Analysis	R 09/08	5	<ul style="list-style-type: none"> • <u>Recitation problems</u> • (video) Introduction to Pandas • Exploratory data analysis; summary statistics and visualizations
4. Hypothesis Testing and Confidence Intervals	T 09/13	6	<ul style="list-style-type: none"> • Binary hypothesis testing • Bootstrap sampling • Permutation tests • Monte Carlo sampling • Confidence intervals
5. Introduction to Statistics	R 09/15	7	<ul style="list-style-type: none"> • Statistical inference • Bayesian hypothesis testing • Decision rules • Maximum Likelihood Estimation (MLE) • Maximum A Posteriori (MAP)
6. Random Variables	T 09/20	8	<ul style="list-style-type: none"> • (video) NumPy Arrays vs. Lists • Introduction to Random Variables (RVs); discrete RVs • Probability Mass Function (PMF) and Cumulative Density Function (CDF)
	R 09/22	9	<ul style="list-style-type: none"> • <u>Recitation problems / Exam review</u>
	T 09/27	10	<ul style="list-style-type: none"> • Important discrete RVs: Bernoulli, Binomial, Geometric and Poisson • Continuous RVs • Properties of CDFs • Probability Density Function (PDF)
<p><i>EXAM 1</i> <i>Covers modules 1-5 (Lectures. #1-7)</i></p>			
6. Random Variables	R 09/29	11	<ul style="list-style-type: none"> • Important continuous RVs: Continuous, Exponential, Gaussian • Case studies of Gaussian RVs • Central Limit Theorem
	T 10/04	12	<ul style="list-style-type: none"> • Expected Value • Introduction to SymPy • Moments of RVs • (video) Kernel Density Estimation (KDE) • (video) Conditioning with Continuous RVs and optimal decisions • Point Conditioning
	R 10/06	13	<ul style="list-style-type: none"> • Analytical hypothesis test • Binary T-test • <u>Recitation problems</u>
7. Experimental Design, Decision and Analysis	T 10/11	14	<ul style="list-style-type: none"> • Errors and performance trade-offs in hypothesis testing • Receiving Operating Characteristics (ROC) curves • Goodness of fit for discrete data: Chi-squared statistic • Goodness of fit for continuous data: Probability plot

	R 10/13	15	<ul style="list-style-type: none"> • Introduction to multi-dimensional data • Categorical data • Contingency tables • Chi-Square Test of Independence • Fisher's Exact Test
8. Introduction to Vectors	T 10/18	16	<ul style="list-style-type: none"> • Recitation problems • Vectors and vector operations • NumPy and vectors
	R 10/20	17	<ul style="list-style-type: none"> • Moments of vectors • Matrices • Pearson's Correlations • Linear Regression • Testing correlation and nonlinear relationships
9. Clustering	T 10/25	18	<ul style="list-style-type: none"> • Norm • Distance • Angle between vectors
	R 10/27	19	<ul style="list-style-type: none"> • Introduction to Clustering • K-Means Clustering • Spyder IDE
<p><i>EXAM 2</i> Covers modules 6-8 (Lectures. #8-17)</p>			
10. Feature Selection and Feature Extraction	T 11/01	20	<ul style="list-style-type: none"> • Vector correlation • Vector projection • Span and bases • Gram-Schmidt Process • Linear Dependence • Dimensionality
	R 11/03	21	<ul style="list-style-type: none"> • Feature selection and weighting • Rotation matrices and matrix multiplication • System of Linear Equations • Row echelon • Gauss-Jordan elimination
11. Data Fitting	T 11/08	22	<ul style="list-style-type: none"> • Recitation problems • Matrix inverses • Determinant of a matrix
	R 11/10	23	<ul style="list-style-type: none"> • Matrix pseudo-inverse • Least Squares solution
	T 11/15	24	<ul style="list-style-type: none"> • Cross-validation • Linear Regression • Bivariate Gaussian RVs
12. Dimensionality Reduction	R 11/17	25	<ul style="list-style-type: none"> • Covariance matrix • Eigen-Decomposition • Orthogonal Bases • Decorrelating Data
	T 11/22	26	<ul style="list-style-type: none"> • Recitation problems
	T 11/29	27	<ul style="list-style-type: none"> • Matrix Factorization • Principal Component Analysis (PCA)
	R 12/01	28	<ul style="list-style-type: none"> • Applications of Dimensionality Reduction • Curse of Dimensionality
	T 12/06	29	<ul style="list-style-type: none"> • Recitation / Final Exam Review
<p><i>Final Exam: 12/15/2022 @ 10:00 AM - 12:00 PM</i> Covers modules 9-12 (Lectures. #18-29)</p>			

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

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/>

1. Course Communications

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.

Questions about grades or personal issues may be emailed to me at shreya.saxena@ufl.edu or within Canvas. You are welcome to talk with me during office hours, or set up an appointment.

We have a Slack page for the course: <https://uf-eel3850-fall2022.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.

2. Attendance Policy

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.

3. Grading Policy

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.

Individual assignments will not be graded on a curve. Final grades course grades will be graded on a curve.

4. Late Work

All submissions are accepted until the assignment solutions are posted but will lose the "on- time" points listed in the rubric.

5. Make-Up Policy

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.

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.

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

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.

7. Cheating and Plagiarism

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.

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

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 questions to be solved on paper, these questions will assess your theoretical understanding on current topics; Part II – consists of programming problems to be implemented using Python and Jupyter Notebooks.

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: these assignments can include short simulation experiments, short analytical problem derivations or reading quizzes. Some of these assignments may be in-class assignments. The timeframe for these assignments is shorter than homework assignments, they serve to help retain information.

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: exam 1 covers modules 1-5, exam 2 covers modules 6-8 and the final exam covers modules 9-12. 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.

Evaluation of Grades

Assignment	Total Points	Percentage of Final Grade
Homework Sets	100 each	15%
Class Participation	5 each	10%
Short Assignments	10 each	15%
Exam 1	100	20%
Exam 2	100	20%
Final Exam	100	20%
Total		100%

Grading Policy

The following is given as an example only.

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

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 support, 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>.