Data Science for ECE

EEL 3850   Section 0001
Class Periods: TR, Period 7 - 8 (1:55 PM - 3:50 PM)
Location: LAR0310
Academic Term: Spring 2023

Instructor: Dr. Jie Fu
Email: fujie@ufl.edu
Phone: (352) 392-2642
Office Hours: Tuesday and Thursday 1:55 PM - 3:50 PM
Slack: https://uf-eel3850-spring2023.slack.com

Teaching Assistant/Peer Mentor/Supervised Teaching Student:
TBD

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):
4 credits of Engineering Science

Relation to Program Outcomes (ABET):

Outcome	Coverage*
7. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	High

8. 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
9. An ability to communicate effectively with a range of audiences	High
10. 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	
11. 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	
12. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	
13. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	

Required Textbooks and Software

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

Please see the College of Engineering computer requirements for minimum hardware requirements and specifications.

2. 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**
    - 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**
    - 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

3. Recommended Materials:
- **Foundations of Data Science with Python**
    - John M. Shea
    - This book is best read online. The online version is freely available and is perfectly fine for this course

Course Schedule

The following schedule is tentative and may vary due to time constraints.

Module	Sections	Topic/s
1. Introduction to Data Science and Python	1	• What is Data Science? • Software setup and installation. • Introduction to Jupyter Notebooks • Introduction to Python, NumPy, Matplotlib • First simulation
2. Introduction to Probability (Sample space and probability)	2	• Set • Fair Experiments and Simulations • Relative Frequency • Probabilistic models
	3	• Discrete sequential models • Conditional probability • Chain Rule
	4	• Total Probability Theorem • Bayes' rule • Applications
	5	• Independence • Counting, Combinatorics
	6	• Recitation
	7	Exam 1
3. Introduction to Probability (Discrete and continuous Random Variables)	8	• Introduction to Random Variables • Important Discrete Random Variables
	9	• Continuous Random Variables • Probability Density Functions • Central limit theorem
	10	• Introduction to Pandas • Exploratory data analysis; summary statistics and visualizations
4. Introduction to Statistics	15	• Introduction to statistical inference • Point estimation • Hypothesis testing
	16	• Classical parameter estimation: Maximum likelihood estimation • Estimation of the Mean and Variance of a Random Variable • Properties of Sum of Independent Gaussian RVs
	17	• Significance testing • Z-test, T-test
	18	• Goodness of fit for discrete data: Chi-squared statistic • Goodness of fit for continuous data: Probability plot
	19	• (Tentative, if time allows) • Introduction to multi-dimensional data • Categorical data • Contingency tables • Chi-Square Test of Independence • Fisher's Exact Test
	20	• Recitation
	21	Exam 2

5. Introduction to vectors	22	• Vectors • Vector additions • Inner product
6 Clustering	23	• Norms • Distance
	24	• Clustering objective • The k-means algorithm • Applications
7. Curve fitting, regression, and correlation	25	• Matrix • Matrix inverse and pseudo inverse • Curve fitting • The method of least square
	27	• (tentative, if time allows)Eigen-decomposition • Principle component analysis
	27	• Recitation/Final Exam Review
	28	Final Exam

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 personal issues may be emailed to me at fujie@ufl.edu . You are welcome to use the telephone (352.392.2642), or talk with me during office hours. If needed, you can request individual appointments.

(c) Questions about grades, Homework, and exams may be emailed to TAs and me. You are encouraged to talk to us during TA/my office hours.

(c) We have a Slack page for the course: https://uf-eel3850-spring2023.slack.comThis 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 <u>will not</u> be graded on a curve. Final grades course grades <u>will</u> 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 <u>until</u> the assignment solutions are posted but will lose the "on-time" points listed in the rubric.

Expectations: I will expect students to follow all deadlines. In case of conflict, I expect that students will communicate with me and let me know well in advance about any conflicting issues in order to avoid losing the "on-time" points.

5. *Make-Up Policy*

General information: (a) if you feel that any graded assignment needs to be re-graded, you must discuss this with the instructor within one week of grades being posted for that assignment. If approved, the entire assignment will be subject to complete evaluation.

(b) if you have an academic conflict with any assignment or exam date/time, please let me know well in advance so we can make the necessary changes and make the appropriate accommodations available.

Expectations: I will expect that students will communicate with me and let me know well in advance about any conflicts or time/date change requests.

Excused absences must be consistent with university policies in the undergraduate catalog (https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx) and require appropriate documentation.

6. *Collaboration*

General information: in solving any individual assignments, healthy discussion and collaboration amongst classmates is encouraged. Healthy collaboration includes: (a) discussing and explaining general course material; (b) discussing assignments for better understanding; (c) aiding for general programming and debugging issues.

Expectations: if another student contributes substantially to your understanding of a problem, you should cite this student to let myself and the teaching assistants be aware of your similar interpretations of a problem. You will not be negatively judged for citing another student.

7. *Cheating and Plagiarism*

General information: while collaboration is encouraged, you are expected to submit your own work and follow the student honor code. Submitting work completed by another student is considered plagiarism and will be dealt according to university policy. In general, if you do not understand your solution, the work is not your own. Examples of plagiarism include: (a) copying (or allowing someone to copy), even partially, an assignment solution or program from the course; (b) submitting material, particularly code, using material taken from another source without proper citation; (c) obtaining solutions to assignments or exams through inappropriate means.

Note that I may elect to use a plagiarism detection service in this course, in which case you will be required to submit your work to such a service as part of your assignment.

Expectations: I expect all students to be bound to the honor pledge as indicated in the student honor code. If you are suspected of dishonest academic activity, I will invite you to discuss it further in private. Academic dishonesty will likely result in grade reduction, with severity depending on the nature of the dishonest activity. I am obligated to report on academic misconduct with a letter to the department, college and/or university leadership. Repeat offences will be treated with significantly greater severity.

8. *Course Etiquette*

- Be present. This will allow you to get the most out of class time as well as for your classmates to get the most out of their collaborations with you.
- Put your cell phone away unless you are actively using it to further the class activities.
- Be prepared. The readings and videos are carefully chosen to support the in-class activities.

- Listen carefully and do not interrupt others.
- Give quality feedback. What constitutes "quality" will be discussed in class.
- Respect the opinions of others, even when you do not agree.
- Keep an open mind, embrace the opportunity to learn something new.
- Avoid monopolizing the discussion. Give others a chance to contribute and be heard.
- Do not be afraid to revise your ideas as you gather more information.
- Try to look at issues from more than one perspective.
- Respect others by learning and using the name and pronoun they prefer.
- Do not use offensive language.

Evaluation of Grades

Assignment	Total Points	Percentage of Final Grade
Homework	100 each	15%
Participation	5 each	10%
Short assignments	10 each	15%
Exam 1	100	20%
Exam 2	100	20%
Final Exam (Exam 3)	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 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. (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. A full practice exam(s) will be posted in canvas.

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:

<u>Health and Wellness</u>

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/.

<u>Academic Resources</u>

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.