Cover Sheet: Request 14731

EEL3XXX Data Science for ECE

Info

Process	Course|New|Ugrad/Pro
Status	Pending at PV - University Curriculum Committee (UCC)
Submitter	Shannon Chillingworth schill@ece.ufl.edu
Created	2/11/2020 8:21:21 AM
Updated	10/12/2020 5:01:24 PM
Description of request	New course

Actions

Step	Status	Group	User	Comment	Updated
Department	Approved	ENG - Electrical and Computer Engineering 011905000	Robert Fox	New course	2/11/2020
No document changes					
College	Conditionall Approved	ENG - College of Engineering	Heidi Dublin	Make up exam policy needs to be in compliance with UF policy, follow UF policy for cheating/plagiarism. Use college template wording. Class participation explanation and add tentative course exam dates--even tentative	2/28/2020
No document changes					
Department	Approved	ENG - Electrical and Computer Engineering 011905000	Robert Fox	Updated syllabus	5/6/2020
No document changes					
College	Approved	ENG - College of Engineering	Heidi Dublin	Approved by HWCOE Curriculum Committee and Faculty Council.	9/15/2020
No document changes					
University Curriculum Committee	Pending	PV - University Curriculum Committee (UCC)			9/15/2020
No document changes					
Statewide Course Numbering System					
No document changes					
Office of the Registrar					
No document changes					
Student Academic Support System					
No document changes					
Catalog					
No document changes					

Step	Status	Group	User	Comment	Updated
College Notified					
No document changes					

Course|New for request 14731

Info

Request: EEL3XXX Data Science for ECE
Description of request: New course
Submitter: Shannon Chillingworth schill@ece.ufl.edu
Created: 10/12/2020 3:52:44 PM
Form version: 3

Responses

Recommended Prefix EEL
Course Level 3
Course Number XXX
Category of Instruction Intermediate
Lab Code None
Course Title Data Science for ECE
Transcript Title Data Science for ECE
Degree Type Baccalaureate

Delivery Method(s) On-Campus
Co-Listing No

Effective Term Earliest Available
Effective Year Earliest Available
Rotating Topic? No
Repeatable Credit? No

Amount of Credit 4

S/U Only? No
Contact Type Regularly Scheduled
Weekly Contact Hours 4
Course Description Analysis, processing, simulation, and reasoning of data. Includes data conditioning and plotting, linear algebra, statistical methods, probability, simulation, and experimental design.
Prerequisites MAC 2312 (C) & EEL 3834 (C).
Co-requisites None
Rationale and Placement in Curriculum This course assures that ECE students will have a good grounding in statistics and linear algebra. This course is specifically customized for the needs of ECE students by also exposing them to a higher level programming language. In addition, this course is essential for students interested in pursuing advanced machine learning course work.
Course Objectives Upon completion of this course, the student should be able to:
• Generate visualizations to expose meaning in data
• Generate and understand the meaning and uses of summary statistics of data
• Model random phenomena using random variables
• Generate random variables with specified densities or distributions
• Conduct hypothesis tests using simulations and analysis
• Understand and use conditioning to simplify problems
• Estimate parameters of distributions from samples
• Understand dependence and independence among random phenomena
• Use statistical tests to determine or characterize dependence among random phenomena
• Design experiments to understand random phenomena
• Understand the difference between Bayesian statistics and classical statistics
• Use simulation to calculate Bayesian statistics
• Apply linear algebra for data processing and statistical calculations
Course Textbook(s) and/or Other Assigned Reading Required Textbooks

Introduction to Probability

o Dimitri P. Bertsekas, John N. Tsitsiklis
o 2nd edition
o Athena Scientific, 2008
o ISBN: 978-1-886529-23-6

Introduction to Applied Linear Algebra – Vectors, Matrices, and Least Squares
o Stephen P. Boyd, Lieven Vandenberghe
o Cambridge University Press, 2018
o ISBN: 978-1-316518-96-0

Think Stats – Exploratory Data Analysis
o 2nd edition
o Allen B. Downey
o O'Reilly Media, 2015
o ISBN: 978-1-491907-33-7

Recommended

Python Data Science Handbook – Essential Tools for Working with Data
o Jake VanderPlas
o O'Reilly Media, 2017
o ISBN: 978-1-491912-05-8
o https://jakevdp.github.io/PythonDataScienceHandbook/

Think Bayes – Bayesian Statistics in Python
o Allen b. Downey
o O'Reilly Media, 2013
o ISBN: 978-1-491945-43-8
o https://greenteapress.com/wp/think-bayes/
Weekly Schedule of Topics Part I: Introduction
Week 1
- Introduction to Python and random module; first simulations
- Counting and visualizing data (scatter plots, histograms); introduction to numpy and matplotlib
- Relative frequency and probability
- (Online) Random experiments, sample spaces, and set operations
Week 2
- Counting and simulation for random draws
- Probability spaces and axioms of probability
- (Online) Corollaries and applications
- Mutually exclusive and statistically independent events
Part II: One-dimensional data
Week 3
- Importing data: Pandas and dataframes
- Summary statistics: average, median, mode, standard deviation/variance; K-means clustering
- Conditional probability and binary hypothesis testing using Fisher's exact test
Week 4
- Binary hypothesis testing using resampling/simulation; p-values and confidence intervals
- Chain rule, total probability, Bayes' rule
- Maximum likelihood (ML) and maximum a posteriori (MAP) decision rules with applications to communications
Week 5
- Discrete random variables and their simulation; introduction to scipy.stats
- Cumulative distribution and survival functions
- Expected value for discrete random variables; moments, mean, variance
- (Online) Poisson random variables
Week 6
- Testing fit of data to discrete distributions
- Continuous random variables and density functions
- Kernel density estimation
Week 7
- Expected value for continuous random variables; moments, mean, variance
- Gaussian random variables and binary hypothesis testing using analytic methods

- Testing whether data comes from distributions: Q-Q plot, skew, kurtosis, Komogorov-Smirnov test
- (Online) Central Limit Theorem
Week 8
- Point conditioning, total probability, Bayes' rule for continuous random variables
- ML decisions with conditionally Gaussian random variables; application to and simulation of communication systems
- (Online) MAP decisions with conditionally Gaussian random variables
- (Online) Introduction to functions of random variables
Part III: Multi-dimensional data
Week 9
- Introduction to two-dimensional data, vectors, and plotting
- Summary statistics (mean, median, variance, covariance, correlation) and K-means clustering
- Chi-squared tests
Week 10
- Constant-vector and vector-vector operations
- Special vector-vector operations and applications
- Norm, distance, Cauchy-Schwartz and triangle inequalities, angles between vectors
Week 11
- Correlation coefficient for n-dimensional data
- Orthonormal bases and Gram-Schmidt algorithm
- Rotation; introduction to matrices and matrix-vector multiplication
Week 12
- Feature weighting and selection using matrix-vector multiplication
- Matrix-matrix operations; transpose; identity matrix
- Understanding and dealing with dependence in data: linear dependence, systems of linear equations,
Gauss-Jordan reduction
Week 13
- Determinants; matrix inverses and their use in solving systems of linear equations
- Jointly distributed random variables; bivariate Gaussians
- Covariance, correlation coefficient, covariance matrix
Week 14
- Linear regression and correlation coefficient
- Nonlinear regression
- Hypothesis testing for correlation
Week 15
- Multi-dimensional Gaussian; covariance matrices
- Orthogonal bases and eigen-decomposition
- Principal component analysis (PCA) and application to data reduction/feature extraction
Grading Scheme Evaluation of Grades
Assignment

Total Points

Percentage of Final Grade
Homework and projects

100 each

15%
In-class Evaluations

100 each

15%
Participation

100

10%
Midterm Exam 1

100

20%
Midterm Exam 2

100

20%
Final Exam

100

20%

100%

Instructor(s) Drs. John Shea and Catia Silva
Attendance & Make-up Yes
Accomodations Yes
UF Grading Policies for assigning Grade Points Yes
Course Evaluation Policy Yes

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Data Science for ECE

EEL 3XXX Section XXXX
Class Periods: MWF, period 6, 12:50 PM – 1:40 PM, R, period 6, 12:50 PM – 1:40 PM
Location: LAR 310 (MWF), WEIL 273 (R)
Academic Term: TBD

Instructor:
Name
Email Address
Office Phone Number
Office Hours: Days of week, hours available, office location

Supervised Teaching Student:
Please contact through the Canvas website
- Name, email address, office location, office hours
  Name, email address, office location, office hours

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 for EE 1)

Course Objectives (as time allows):
Upon completion of this course, the student should be able to:
- Generate visualizations to expose meaning in data
- Generate and understand the meaning and uses of summary statistics of data
- Model random phenomena using random variables
- Generate random variables with specified densities or distributions
- Conduct hypothesis tests using simulations and analysis
- Understand and use conditioning to simplify problems
- Estimate parameters of distributions from samples
- Understand dependence and independence among random phenomena
- Use statistical tests to determine or characterize dependence among random phenomena
- Design experiments to understand random phenomena
- Understand the difference between Bayesian statistics and classical statistics
- Use simulation to calculate Bayesian statistics
- 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*
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

- Introduction to Probability
  - Dimitri P. Bertsekas, John N. Tsitsiklis
  - 2nd edition
  - Athena Scientific, 2008
  - ISBN: 978-1-886529-23-6
  - An e-book version will be cheaper and is perfectly fine for this course: you can access it for free here

- Introduction to Applied Linear Algebra – Vectors, Matrices, and Least Squares
  - Stephen P. Boyd, Lieven Vandenberghe
  - Cambridge University Press, 2018
  - ISBN: 978-1-316518-96-0
  - An e-book version will be cheaper and is perfectly fine for this course: you can access it for free here
- Think Stats – Exploratory Data Analysis
  - 2nd edition
  - Allen B. Downey
  - O'Reilly Media, 2015
  - ISBN: 978-1-491907-33-7
  - An e-book version will be cheaper and is perfectly fine for this course: you can access it for free here

In addition to freely accessible digital copies, all required textbooks are listed on Courses Reserves. One (1) physical copy will be available for semester-long use at the Marston library. Please find this course on

https://ares.uflib.ufl.edu/ares/ to access the Catalogue record. You can also find this information under the icon "Course Reserves" in our Canvas page.

Recommended Textbooks

- Python Data Science Handbook – Essential Tools for Working with Data
  - Jake VanderPlas
  - O'Reilly Media, 2017
  - ISBN: 978-1-491912-05-8
  - https://jakevdp.github.io/PythonDataScienceHandbook/

- Think Bayes – Bayesian Statistics in Python
  - Allen b. Downey
  - O'Reilly Media, 2013
  - ISBN: 978-1-491945-43-8
  - https://greenteapress.com/wp/think-bayes/

Course Schedule (as time allows)

Online* - refers to short (< 20 min) pre-recorded videos to watch as a preparation or complement of a class meeting.

Part I: Introduction

Week 1

- Introduction to Python and random module; first simulations
- Counting and visualizing data (scatter plots, histograms); introduction to numpy and matplotlib
- Relative frequency and probability
- (Online*) Random experiments, sample spaces, and set operations

Week 2

- Counting and simulation for random draws
- Probability spaces and axioms of probability
- (Online*) Corollaries and applications
- Mutually exclusive and statistically independent events

Part II: One-dimensional data

Week 3

- Importing data: Pandas and dataframes
- Summary statistics: average, median, mode, standard deviation/variance; K-means clustering
- Conditional probability and binary hypothesis testing using Fisher's exact test

Week 4

- Binary hypothesis testing using resampling/simulation; p-values and confidence intervals
- Chain rule, total probability, Bayes' rule
- Maximum likelihood (ML) and maximum a posteriori (MAP) decision rules with applications to communications

Week 5

- Discrete random variables and their simulation; introduction to scipy.stats
- Cumulative distribution and survival functions
- Expected value for discrete random variables; moments, mean, variance
- (Online*) Poisson random variables

Week 6

- Testing fit of data to discrete distributions

- Continuous random variables and density functions
- Kernel density estimation

Week 7

- Expected value for continuous random variables; moments, mean, variance
- Gaussian random variables and binary hypothesis testing using analytic methods
- Testing whether data comes from distributions: Q-Q plot, skew, kurtosis, Kolmogorov-Smirnov test
- (Online*) Central Limit Theorem

MIDTERM EXAM 1

Week 8

- Point conditioning, total probability, Bayes' rule for continuous random variables
- ML decisions with conditionally Gaussian random variables; application to and simulation of communication systems
- (Online*) MAP decisions with conditionally Gaussian random variables
- (Online*) Introduction to functions of random variables

Part III: Multi-dimensional data

Week 9

- Introduction to two-dimensional data, vectors, and plotting
- Summary statistics (mean, median, variance, covariance, correlation) and K-means clustering
- Chi-squared tests

Week 10

- Constant-vector and vector-vector operations
- Special vector-vector operations and applications
- Norm, distance, Cauchy-Schwartz and triangle inequalities, angles between vectors

Week 11

- Correlation coefficient for n-dimensional data
- Orthonormal bases and Gram-Schmidt algorithm
- Rotation; introduction to matrices and matrix-vector multiplication

MIDTERM EXAM 2

Week 12

- Feature weighting and selection using matrix-vector multiplication
- Matrix-matrix operations; transpose; identity matrix
- Understanding and dealing with dependence in data: linear dependence, systems of linear equations, Gauss-Jordan reduction

Week 13

- Determinants; matrix inverses and their use in solving systems of linear equations
- Jointly distributed random variables; bivariate Gaussians
- Covariance, correlation coefficient, covariance matrix

Week 14

- Linear regression and correlation coefficient
- Nonlinear regression
- Hypothesis testing for correlation

Week 15

- Multi-dimensional Gaussian; covariance matrices
- Orthogonal bases and eigen-decomposition
- Principal component analysis (PCA) and application to data reduction/feature extraction

FINAL EXAM

Attendance Policy, Class Expectations, and Make-Up Policy

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.

Evaluation of Grades

Assignment	Total Points	Percentage of Final Grade
Homework	100 each	20%
Short Assignments	10 each	10%
Participation	Up to 5	10%
Midterm Exam 1	100	20%
Midterm Exam 2	100	20%
Final Exam	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 parts: Part I – analytical questions that assess the theoretical component of the course; Part II – consists of Python simulation problems that assess Python programming.

- **Participation:** Students are expected to contribute to the learning environment in the class through active participation. However, students may participate in many different forms, which may be inside or outside of class. The instructor(s) will assess students' participation across many modalities, including in class, on E-Learning (through Discussions, comments, or emails), in office hours, and through messaging (both text messages and messaging apps such as Slack, when offered). Participation will range from 1 to 5, where 5 (maximum points awarded) indicates very high participation level in one or more modalities, and grade of 1 (minimum points awarded) indicates no participation (not attending class, not participating in class discussions).

- **Short Assignments:** will typically consist of short Python implementations or short analytical derivations. These assignments serve to aid student learning as they provide short and immediate practical experience on topics learned in class. Furthermore, these assignments will have a shorter completion timeframe (2-3 weekdays).

- **Exams:** The exams will be drawn evenly from all lectures, assignments, and readings that occurred up to that point in the course. None of the exams will cover any other topics outside of the ones listed, although some concepts are in nature cumulative. You are responsible for all assigned material. A full practice exam(s) will be posted in canvas. Students should have a notebook up and running for the exam to assist with validating answers to code completion problems.

Grading Policy

Grades (and the corresponding grade points) will be assigned according to the Registrar's official policies (see table below). Grades will be curved. However, an A grade of > 90% is guaranteed an A, > 80% is guaranteed a B, etc. Undergraduate students, in order to graduate, must have an overall GPA and an upper-division GPA of 2.0 or better (C or better). Note: a C- average is equivalent to a GPA of 1.67, and therefore, it does not satisfy this graduation requirement. Graduate students, in order to graduate, must have an overall 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.

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

For more information on grades and grading policies, please visit:
https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx

Students Requiring Accommodations
Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, https://www.dso.ufl.edu/drc) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure 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://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf.

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