

# **EEL 4930 SYLLABUS**

## **DATA SCIENCE FOR ECE**

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# WHAT IS DATA SCIENCE?

- Generate **meaning** from **data**
- Examples:
  - Do gun laws reduce firearms mortality?
  - If we look at the effect of state laws on firearms mortalities, what other factors might be responsible for any observed differences? Do urban and rural states have different firearms mortalities? How about richer or poorer states?

- Do males score higher on standardized high school math and science tests than females?

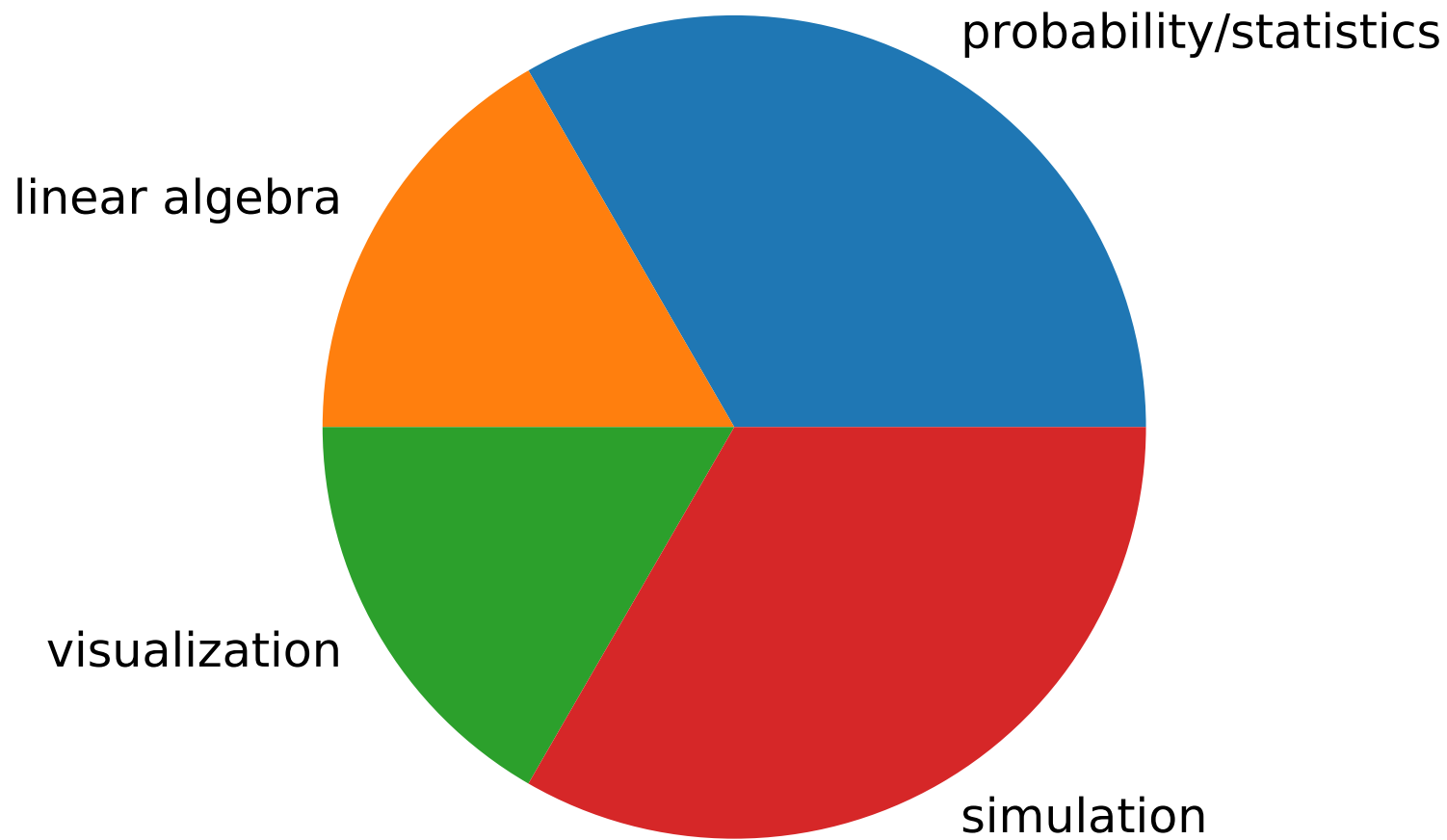
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- Do first pregnancies last longer than other pregnancies?
- How should we measure the effectiveness of medical tests, including risks associated with false identification of disease and missed detection of disease?

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# Why should you care?



## 1. Data Scientist

**Overall Rating: 91**

**Median Salary: \$128,240**

**Projected Growth: 16.02%**



## 2. Statistician

**Overall Rating: 92**

**Median Salary: \$80,295**

**Projected Growth: 36.53%**

1. **Catalog Description:** (3 credits) Analysis, processing, simulation, and reasoning for data. Includes data conditioning and plotting, linear algebra, statistical methods, probability, simulation, and experimental design.

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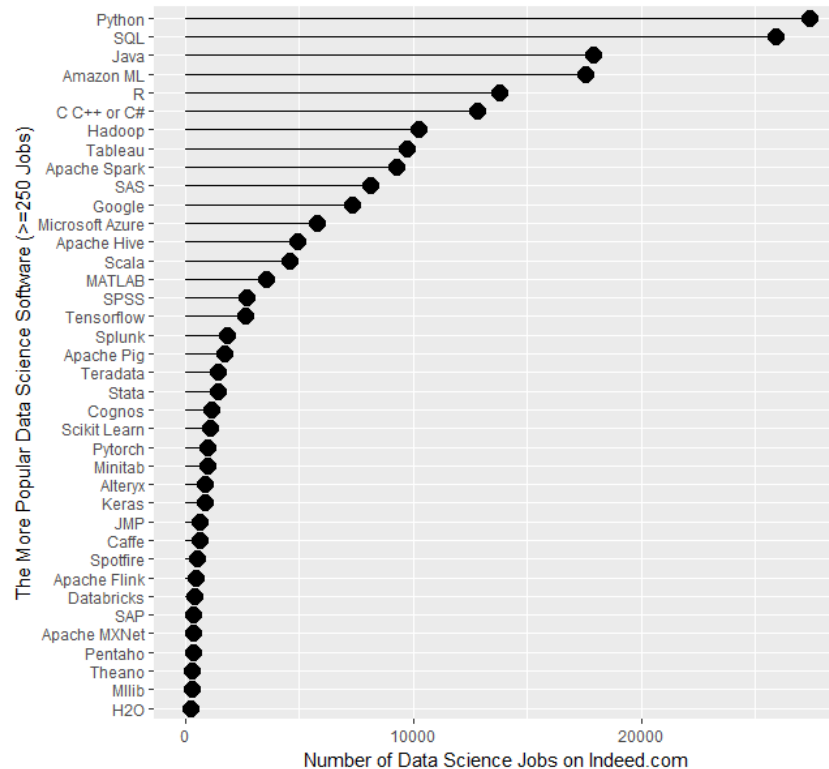


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- We will use Python almost every day, for class assignments, **and for exams**





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- However, you do need good basic programming skills to do well in this course

- We will **not** teach you everything you need to know about Python during class hours; instead, we will teach you how to use it for visualization, data processing, simulation, etc.

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  - We **will** provide you with lots of resources and help to get going in Python
  - The TAs and Professors will be available during office hours to help you with Python issues

- We will also be doing analytical probability and statistics, which will require you to be proficient in calculus

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  - No prior knowledge of probability or statistics is needed

**2. Pre-requisite: MAC 2312 (Calculus 2)**



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**Other: Students are expected to bring a portable computer to class. Students need basic computer programming skills.**

**3. Course Objectives (as time allows):** Upon completion of this course, the student should be able to

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- 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

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- Estimate parameters of distributions from samples



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- 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

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- Use simulation to calculate Bayesian statistics
- Apply linear algebra for data processing and statistical calculations

**4. Contribution of course to meeting the professional component: 4 credits of Engineering Science**

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## **5. Relationship of course to program outcomes:**

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

## **6. Instructors:**

- Dr. John M. Shea  
(a) Office: 439 NEB

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(b) Phone: 352.575.0740 (text messaging is okay)

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(c) Email: [jshea@ece.ufl.edu](mailto:jshea@ece.ufl.edu)

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(d) Web site (personal): <http://wireless.ece.ufl.edu/jshea>

(e) Office hours: Mondays and Thursdays 2:00 PM –  
3:30 PM

- Dr. Catia S. Silva  
(a) Office: NEB 467

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  - (b) Phone: 352.392.6502



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- Dr. Catia S. Silva
  - (a) Office: NEB 467
  - (b) Phone: 352.392.6502
  - (c) Email: [catiaspsilva@ece.ufl.edu](mailto:catiaspsilva@ece.ufl.edu)
  - (d) Office hours: 10:40 AM–11:40 AM, or by appointment

## **7. Teaching Assistant and Supervised Teacher:**

- Quan Pham (Teaching Assistant)  
(a) Office: NEB 405

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(a) Office: NEB 405

(b) Phone: (518)290-0421 (text preferred)

(c) Email: [quanpham@ufl.edu](mailto:quanpham@ufl.edu)

(d) Office hours: Tuesday 11:45am-1:40pm

- Ying Ma (Supervised Teaching Student)

(a) Office: NEB 454

(b) Email: [mayinggator@ufl.edu](mailto:mayinggator@ufl.edu)

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- (b) Email: [mayinggator@ufl.edu](mailto:mayinggator@ufl.edu)

- (c) Office hours: Wednesday 11 AM – 12 PM

- 8. **Meeting Times:** 6th period, 12:50 PM – 1:40 PM  
MWRF
- 9. **Class/laboratory schedule:** 3 classes/week, 50  
minutes each
- 10. **Meeting Location:** LAR 310 (MWF)/Weil 273 (R)
- 11. **Material and Supply Fees:** None



## 12. Textbooks and Software Required:

- A. B. Downey, *Think Stats*, O'Reily Media, 2nd ed., 2014.

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- A. B. Downey, *Think Stats*, O'Reily Media, 2nd ed., 2014.
- D. P. Bertsekas and J. N. Tsitsiklis, *Introduction to Probability*, Athena Scientific, 2nd ed., 2008 (ISBN 978-1-886529-23-6). (Recommended.)
- S. Boyd and L. Vandenberghe, *Introduction to Applied Linear Algebra – Vectors, Matrices, and Least Squares*, Cambridge University Press, 1st ed, 2018 (ISBN 978-1-316518-96-0). (Recommended, available online.)

## 13. **Course Outline (as time allows):**

### **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 eigendecomposition
- Principal component analysis (PCA) and application to data reduction/feature extraction

### **3. Attendance and Expectations:**

- Students are expected to attend class, and graded evaluations (exercises and/or quizzes) will be given during class.
- Students are expected to bring a portable computer to class.
- If you feel a graded assignment or exam needs to be re-graded, you must discuss this with the instructor within one week of grades being posted for that assignment/exam.
  - If approved, we reserve the right to regard the entire assignment or exam.

- If an exam must be missed, the student must see the instructor and make arrangements in advance unless an emergency makes this impossible. Approval for make-up exams is much more likely if the student is willing to take the exam early. Any other exam absence will result in the student receiving a zero for that grade. Students who miss pop quizzes or online quizzes will receive zeros for that grade.

- **Any student found to have cheated or plagiarized on an exam or assignment will be given a grade of 0 for that exam or assignment and the evidence will be sent to the Provost's Office for the determination of any additional disciplinary action.**

- Unless an assignment is specifically structured as a group project, duplicate assignments written in collaboration with others is not acceptable. Although it is permissible to discuss the homework with others, these discussions should be of a general nature. All work at a detailed level must be done on your own. Students submitting the same or similar solutions to the homework will be considered as having cheated. No statements or actions made by anyone can alter this policy. Please review what constitutes plagiarism: <https://guides.uflib.ufl.edu/copyright/plagiarism>

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

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4. **Grading:** Grading will be based on two exams (30% each) homework and projects (20%), in-class evaluations(10%), and participation (10%).



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**6. 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.

**7. Course Evaluation:** Students are expected to provide feedback on the quality of instruction in this course by completing online evaluations at <https://evaluations.ufl.edu/evals>. Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students at <https://evaluations.ufl.edu/results/>.

**8. 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.”

*Additional requirements and information:*

Honor statements on tests must be signed in order to receive any credit for that test.



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Collaboration on homework is permitted **and encouraged** unless explicitly prohibited, provided that:

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- (b) Collaboration must be a shared effort.
- (c) Each student must write up his/her homework independently.

(d) On problems involving programming, each student should write their own program.

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**9. 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](mailto:rbielling@eng.ufl.edu)
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, [taylor@eng.ufl.edu](mailto:taylor@eng.ufl.edu)
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, [nishida@eng.ufl.edu](mailto:nishida@eng.ufl.edu)

**10. Software Use:** All faculty, staff and student 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.

11. **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>

## 12. Campus Resources:

*(Complete list in online syllabus)*

### **Health and Wellness: U Matter, We Care:**

If you or a friend is in distress, please contact [umatter@ufl.edu](mailto: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. In case of emergency, call 9-1-1.