STA 2170: Statistics in the Physical World

Quest 2

Course Information

Fall 2025 (3 Credit Hours)
Honors Section 27993 (Section 1565)
Meeting Day/Time: T4, R4-5
Location: T: MAEA0327
Primary General Education Designation: Physical Sciences
Secondary General Education Designation (if seeking): No Secondary Designation
Writing Designation (if seeking): No writing designation
A minimum grade of C is required for general education

Instructor

Larry Winner – winner@ufl.edu
Office location: 228 Griffin/Floyd Hall
Office hours: M 9:30-11:00, Tu 12:00-1:30, W 11:00-1:00, Th 1:00-2:30
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Course Description

This course is intended to introduce general ideas involving probability and statistics through thought provoking examples from subject areas in the physical and biological sciences. Students will be expected to think through solutions to problems from the various cases to understand the various statistical methods introduced. This can lead to questions such as how can we measure and describe climate change based on available empirical data? The course will focus on "big picture" uses of statistical methods and will use statistical computing software as opposed to "hand calculation." This course affords students the ability to critically examine and evaluate the principles of the scientific method, model construction, and use the scientific method to explain natural experiences and phenomena.

General Education Objectives and Learning Outcomes

This course is a social and behavioral sciences (S) subject area course in the UF General Education Program. Physical science courses provide instruction in the basic concepts, theories and terms of the scientific method in the context of the physical sciences. Courses focus on major scientific developments and their impacts on society, science and the environment, and the relevant processes that govern physical systems. Students will formulate empirically-testable hypotheses derived from the study of physical processes, apply logical reasoning skills through scientific criticism and argument, and apply techniques of discovery and critical thinking to evaluate outcomes of experiments.

These general education objectives will be accomplished through:

1. Studying individuals' knowledge and attitudes regarding weather in terms of understanding of commonly reported measures of probability and the effects of framing options in terms of gains/losses. Further, statistical methods will be applied to quantify changes in global temperature.
2. Describe and analyze historical measurements from experiments of the speed of light, and the density of the earth.
3. Students will use statistical methods to test empirically test widespread believed (as well as denied) hypotheses regarding climate change, as well as confirming that historic physical measurements are consistent with modern true values for scientific parameters. Further, they will be presenting their reports/results in projects.
4. Providing students to survey a group of individuals on a widely reported measure of uncertainty in future weather and the effects of framing on individuals' choices involving choices with regards to climate change.
5. Make use of external data sources of physical sciences and use statistical computing to describe and analyze the data. Students will conduct two surveys/questionnaires to elicit people's understanding and attitudes toward physical science information.

At the end of this course, students will be expected to have achieved the following learning outcomes in content, communication and critical thinking:

- **Content:** *Students will identify, describe, and explain the basic concepts, theories and terminology of natural science and the scientific method; the major scientific discoveries and the impacts on society and the environment; and the relevant processes that govern biological and physical systems.* Students will identify, describe, and explain physical science data measurements; ways to apply the scientific method to test hypotheses regarding changes over time in physical systems. Assessments will be made with in-class activities, projects, and exams.
- **Critical Thinking:** *Students will formulate empirically-testable hypotheses derived from the study of physical processes or living things; apply logical reasoning skills effectively through scientific criticism and argument; and apply techniques of discovery and critical thinking*

effectively to solve scientific problems and to evaluate outcomes. Students will analyze and evaluate models that test whether people's attitudes toward physical processes depend on framing of choices. Critically analyze data to confirm whether widely held views regarding climate change are consistent with empirical data. Assessments will be made with in-class activities, projects, and exams.

- **Communication:** *Students will communicate scientific knowledge, thoughts, and reasoning clearly and effectively.* Students will report on statistical analysis of people's attitudes to choices based on the framing of the choices. They will also report on statistical analyses of global warming with numeric and graphical presentation. Assessments will be made with projects.
- **Connection:** *Students connect course content with meaningful critical reflection on their intellectual, personal, and professional development at UF and beyond.* Students will conduct a final project combining statistical methods with real world climate data and give a report on temperature trends for a sample of cities within the US. They will include their reflections on the results of this in their Self-Reflection paper.

Statement on Experiential Learning

We will make use of the UF Libraries' search engines to compile a research report and bibliography for various themed topics. There will be a list of research questions and each student will obtain a list of academic papers that are related to the research questions. Students will prepare a summary of the results of the papers and the bibliography of the papers.

Required & Recommended Course Materials

STA 2170 – Course Notes Packet – Available at on UF Canvas and my UF Webpage

Datasets and Computer Programs available on UF Canvas webpage

Coursework & Schedule

List of Graded Work

Assignment	Description	Requirements	Points
In-Class Data Collection	On 5 randomly selected class dates, students will participate in an in-class data collection that will be analyzed in subsequent lectures.		5

Project 1	Describing Data: Orlando monthly mean temperature and Rainfall Totals.	Provide plots and numeric description of your results.	3
Project 2	Interpreting probabilities: Conduct a survey to measure people's understanding of the term "Probability of Precipitation" for daily rainfall.	Brief Report of your results in graphical and tabular form and summary	12
Project 3	Comparing Groups: Hypothesize what you would expect to see with annual temperature data over the decades 1970s,1980, 1990s, 2000s. Obtain temperature data for a sample of cities around the world and compare the average temperatures by decade and analyze as a Randomized Block Design (decades as treatments, cities as blocks). Do your data conform to your hypotheses?	Brief Report containing description of the data, methods, results, graphical plots, and summary.	15
Project 4	Categorical Data Analysis: Create an instrument to pose outcomes of a climate change intervention in terms of gains and losses. Conduct a survey of individuals and test whether people's choices differ when framed as gains or losses (prospect theory). Conduct a chi-square test to determine whether incidence of cyclones varies by season across three latitude ranges in Antarctica.	Brief Report containing the development of choice scenarios offered, tables containing results, methods, and summary.	15
Project 5	Linear Regression: Fit linear trend models relating average annual temperature (Y) to year (X) for a sample of 6 cities for years 1960-2020.	Brief Report containing description of the data, methods, results,	15

		graphical plots, and summary.	
In-Class Activity 1	Obtaining numerical descriptive measures and graphs based on various experiment-based datasets	Provide answers to worksheet questions	3
In-Class Activity 2	Describing physical data with probability distributions	Provide answers to worksheet questions	3
In-Class Activity 3	Demonstration of statistical inference regarding sampling of professional athletes' Body Mass Indices (BMI)	Provide answers to worksheet questions	3
In-Class Activity 4	Measure predictive ability of the forensic gender prediction method covered in class.	Provide answers to worksheet questions	3
Self-Reflection Assessment	Students give report on how their views of climate change have been changed over the course of their semester.	Report	3
Midterm Exam	Open-note in-class exam relating statistical methods to physical science (Approximately Chapters 1-4)	Exam	25
Final Exam	Open-note in-class exam relating statistical methods to physical science (Approximately Chapters 5-9)	Exam	25
Experiential Project	Report and Bibliography regarding research question of interest.	Brief report and bibliography	10
Total			140

Tentative Weekly Course Schedule

Week/ Date	Activity	Topic/Assignment (Question/Subject)	Assigned Work Due
Week 1 8/21	Topic	Introduction	
	Summary	Definitions and Terminology, Classic applications, Scientific Method, Data sources, Computational Software	
	Readings/Works	Course Notes: Chapter 1 (6 pp) Scientific Method: Steps and Examples by Linda Rasmussen - UCSD (3 pp) Deductive and Inductive Reasoning (Bacon vs Aristotle - Scientific Revolution) - YouTube (8:46) http://www.rebresearch.com/blog/the-scientific-method-isnt-the-method-of-scientists/ (approx. 3 pp) Murphy, A.H., Lichtenstein, S., Fischhoff, B., and Winkler, R.L. (1980). "Misinterpretation of Precipitation Probability Forecasts," *Bulletin of the American Meteorological Society*, Vol. 61, #7, pp. 695-701. (7 pp)	
Week 2 8/25-8/29	Topic	Describing data. Numeric measures (mean, median, variance, standard deviation, correlations). Graphical methods (pie charts, histograms, box plots, scatterplots, bar charts, time series plots, control charts).	
	Summary	Describing historical physical data: Measurements of the speed of light (Michelson), Parallax of the sun (Short). Temperature data over time.	
	Readings/Works	Course Notes: Chapter 2	

Week/ Date	Activity	Topic/Assignment (Question/Subject)	Assigned Work Due
		History of Statistics 3: "Origin of Graphs in Statistics – William Playfair (1759-1823)," Vermont Mathematics Initiative, Bob Rosenfeld (4 pp) https://www.atlasobscura.com/articles/the-scottish-scoundrel-who-changed-how-we-see-data Michelson, A.A., Pease, F.G. and Pearson, F. (1935). "Measurement of the Velocity of Light in a Partial Vacuum," *Astrophysical Journal*, Vol. 82, pp. 26-61. (Description of experiment and tabulated data 36 pp – will only cover pictures, formulas and data table).	
	Assignment	Project 1	9/7
Week 3 9/2-9/5	Topic	Developments in Measurement. Introduction to Normal distribution.	
	Summary	Francis Galton measures many physical characteristics of humans, plants, and animals. Demonstrates that many natural measurements tend to follow normal distributions. Shows that measurements involving hereditary and chance (environmental) influences tend to "regress to the mean."	
	Readings/Works	Course Notes: Chapter 2 (20 pp) https://medium.com/@will.a.sundstrom/the-origins-of-the-normal-distribution-f64e1575de29	
	Assignment	In-Class Activity 1 – Obtaining numerical descriptive measures and graphs based on various experiment-based datasets	9/7

Week/ Date	Activity	Topic/Assignment (Question/Subject)	Assigned Work Due
Week 4 9/8-9/12	Topic	Basic Probability	
	Summary	Developments of probabilistic reasoning in Europe. Problems involving dice and splitting of prize in incomplete contests. Conditional Probability. Bayes' Theorem. Applications and examples.	
	Readings/Works	https://www.cut-the-knot.org/Probability/ChevalierDeMere.shtml History of Probability 2: "17th Century France The Problem of Points: Pascal, Fermat, and Huygens," Vermont Mathematics Initiative, Bob Rosenfeld (4 pp) History of Probability 4: "Inverse probability and the determination of causes of observed events. Thomas Bayes (c1702-1761)," Vermont Mathematics Initiative, Bob Rosenfeld (4 pp) Yudkowsky, E.S. "An Intuitive Explanation of Bayes' Theorem," https://arbital.com/p/bayes_rule/?l=1zq (Approx4-6 pages) Course Notes: Sections 3.1.1-3.1.2 (6 pp)	
	Assignment	Project 2	9/14
Week 5 9/15-9/19	Topic	Random Variables, Probability Distributions and their applications	
	Summary	Binomial, Poisson, Normal, and Gamma families of distributions. Binomial – Testing for defectives, Drug trials, Weather patterns Poisson – Locations of Bombs in London During WWII Normal – Lengths of physical characteristics, IQ scores, Central Limit Theorem Gamma – Rainfall amounts, Marathon running speeds	
	Readings/Works	Course Notes – Sections 3.2-3.4 (15 pp) Bhatia, A. (2012) What does randomness look like? Wired 12.21.201 (~4-5 pp)	
	Assignment	In-Class Activity 2 – Describing physical data with probability distributions	9/21

Week/ Date	Activity	Topic/Assignment (Question/Subject)	Assigned Work Due
Week 6 9/22-9/26	Topic	Sampling Distributions and Introduction to Statistical Inference	
	Summary	Central Limit Theorem, Interval Estimation, Hypothesis Testing Estimating a population mean (true value) based on samples (repeat observations of phenomena). Testing hypotheses regarding the unknown population mean.	
	Readings/Works	Course Notes – Sections 3.5, Chapter 4 (13 pp) Nuzzo, R. (2014). "Scientific Method: Statistical Errors," *Nature*, Vol. 506, pp. 150-152 (13 February 2014). (3 pp) Jeff Whitmer Editor-in-Chief (2019) Editorial, *Journal of Statistical Education*, 27:3, pp. 136-137, DOI:10.1080/10691898.2019.1702415 Andrew Gelman, "Too Good to Be True," Slate, July 24, 2013 (Approx 5 pp) https://slate.com/technology/2013/07/statistics-and-psychology-multiple-comparisons-give-spurious-results.html https://www.skeptic.org.uk/2024/07/what-does-p-hacking-really-mean-and-why-is-it-a-problem/ Efron, B. (2013). "Bayes' Theorem in the 21st Century," *Science*, Vol. 340, pp. 1177-1178. (7 June 2013). (2 pp)	
	Assignment	In-Class Activity 3 – Demonstration of statistical inference regarding sampling of professional athletes' Body Mass Indices (BMI).	9/30

Week/ Date	Activity	Topic/Assignment (Question/Subject)	Assigned Work Due
Week 7 9/29-10/3	Topic	Introduction to Experimentation	
	Summary	Completely Randomized Designs – Designs to compare two or more conditions with independent samples of experimental/observational units. Block/Matched Designs – Designs to compare two or more conditions when units have been matched or are each observed in the various conditions. Factorial Designs – Designs to measure the effects of two or more factors (variables) on outcomes. Chi-Square Tests – Tests for association between two or more categorical variables. Linear Regression – Methods for studying associations among numeric and categorical predictors on a numeric outcome.	
	Readings/Works	Course Notes – Chapter 5 (2 pp) History of Statistics 8: "Analysis of Variance and Design of Experiments – R.A. Fisher (1890-1962)." Vermont Mathematics Initiative, Bob Rosenfeld (4 pp) https://mathshistory.st-andrews.ac.uk/Biographies/Fisher/ https://www.sciencehistory.org/stories/magazine/ronald-fisher-a-bad-cup-of-tea-and-the-birth-of-modern-statistics/ https://www.wired.com/story/how-a-cup-of-tea-laid-the-foundations-for-modern-statistical-analysis-adam-kucharski-proof-book/	
	Assignment	Midterm Exam (Permitted 2 sheets of 8.5x11" for Notes/Formulas)	9/30
Week 8 10/6-10/10	Topic	Comparing 2 populations – numeric outcomes –Independent and Paired samples	
	Summary	Independent sample t-test/Confidence Intervals – Case TBD Paired t-test/Confidence Intervals – Stroop interference effect (Psychology)	

Week/ Date	Activity	Topic/Assignment (Question/Subject)	Assigned Work Due
	Readings/Works	Course Notes – Chapter 6 (15 pp) https://www.cmaj.ca/content/cmaj/180/1/23.full.pdf Livingston, E.H. (2004). "Who Was Student and Why Do We Care So Much About his *t*-test?," *Journal of Surgical Research*, Vol. 118, #1, pp. 58-65. (8 pp) Redelmeier, D.A. and S.D. Baxter (2009). "Rainy Weather and Medical School Admission Interviews," *CMAJ* 2009. DOI:10.1503/cmaj.091546	
	Assignment	Project 3	10/12
Week 9 10/13-10/16	Topic	Comparing more than 2 populations – Completely Randomized and Randomized Block Designs	
	Summary	1-Way ANOVA for the Completely Randomized Design – Comparing 5 mosquito repellents Randomized Block Design – Case TBD	
	Readings/Works	Course Notes – Sections 7.1-2 (21 pp) Larson, M.G. (2008). "Analysis of Variance," *Circulation*, Vol. 117, #1, pp. 115-121. (Section on One-Way Fixed Effects ANOVA) (3-4 pp)	
Week 10 10/20-10/24	Topic	Factorial Designs for multiple treatment factors	
	Summary	Additive Models – E-reader model type and illumination level on reading times Interaction Models – Effects of Base diet (corn/sorghum) and methionine (present/absent) on weights of broiler chickens	
	Readings/Works	Course Notes – Section 7.3 (Will be approx. 10-12 pp) Larson, M.G. (2008). "Analysis of Variance," *Circulation*, Vol. 117, #1, pp. 115-121. (Section on Two-Way Fixed Effects ANOVA) (3-4 pp)	

Week/ Date	Activity	Topic/Assignment (Question/Subject)	Assigned Work Due
Week 11 10/27-10/31	Topic	Categorical Data Analysis	
	Summary	Estimating and Testing a Proportion – ESP studies, Food/Beverage Tasting Comparing 2 Proportions (independent and paired samples) – Tests of prospect theory Chi-square tests – Archaeological study of Paleoindian rock art in the Great Basin	
	Readings/Works	Course Notes – Chapter 8 (14 pp) Kahneman, D. and Tversky, A. (1979). "Prospect Theory: An Analysis of Decision Under Risk," Econometrica, Vol. 47, pp. 263-291. (29 pp, will only cover the empirical examples)	
	Assignment	Project 4	11/9
Week 12 11/3-11/7	Topic	Simple Linear Regression and Correlation	
	Summary	Estimating a linear relation between a numeric predictor and a numeric response variable – Galton's measurements of height on adult children and their parents. Measuring the correlation between two numeric variables – Correlations among weather characteristics.	
	Readings/Works	Course Notes – Section 9.1 (12 pp) Ward, B. "Anthropogenic Global Warming 'Stopped' in 1997 … and in 1996, 1995, 1982, 1981, 1980, 1979, 1978 and 1972," https://www.lse.ac.uk/granthaminstitute/news/anthropogenic-global-warming-stopped-in-1997and-in-1996-1995-1982-1981-1980-1979-1978-and-1972/ (Approx 3-4 pp)	
Week 13 11/10-11/14	Topic	Multiple Linear Regression	
	Summary	Models with multiple predictor (input) variables and a numeric response.	

Week/ Date	Activity	Topic/Assignment (Question/Subject)	Assigned Work Due
	Readings/Works	Course Notes – Section 9.2 (11 pp) Navid, M.A.I. and Niloy, N.H. (2018). "Multiple Regressions for Predicting Rainfall for Bangladesh," *Communications*, Vol. 6, #1, pp. 1-4. (4 pp) http://www.sciencepublishinggroup.com/j/com/	
	Assignment	Project 5	11/30
Week 14 11/17-11/21	Topic	Logistic Regression	
	Summary	Models for predicting binary responses (Presence/Absence) of a characteristic with one or more predictor variables. Prediction of gender from lengths of body parts in young adults.	
	Readings/Works	Course Notes – Section 9.3 (Will be approximately 5-7 pp) Merenti-Valimaki, H-L, Laininen, P. (2002). "Analysing Effects of Meteorological Variables on Weather Codes by Logistic Regression," *Meteorological Applications*, Vol. 9, #2, pp. 191-197. (7 pp)	
	Assignment	In-Class Activity 4 - Measure predictive ability of the forensic gender prediction method covered in class.	11/20
Week 15 12/1-12/3	Topic	Course Review/Self Reflection	
	Summary		
	Readings/Works		
	Assignment	Bibliography/Report Self-Reflection Assessment – Students give report on how their views of climate change have been changed over the course of their semester.	12/7
	Assignment	Final Exam (Permitted 2 sheets of 8.5x11" for Notes/Formulas)	12/2

Week/ Date	Activity	Topic/Assignment (Question/Subject)	Assigned Work Due

Statement on Attendance and Participation

Attendance and Participation:

Requirements for class attendance and make-up exams, assignments, and other work in this course are consistent with university policies that can be found at: https://catalog.ufl.edu/UGRD/academic-regulations/attendance-policies/

Grading Scale

For information on how UF assigns grade points, visit: https://catalog.ufl.edu/UGRD/academic-regulations/grades-grading-policies/

A	130-140 points		C	87-95- points
A-	120-130- points		C-	78-87- points
B+	115-120- points		D+	70-78- points
B	109-115- points		D	63-70- points
B-	103-109- points		D-	56-63- points
C+	95-103- points		E	<56 points

A minimum grade of B is required to earn Academic points towards your Honors Completion Requirements. (Exception: Honors Quest I and II sections require a C). Once you have earned your final grade in this course, please upload the course information and final grade from your Unofficial Transcript into your Honors Canvas Cohort: Honors Completion module to earn Honors Completion credit.

Students Requiring Accommodation

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.

UF Evaluations Process

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online. Students can complete evaluations in three ways:

1. The email they receive from GatorEvals,

2. Their Canvas course menu under GatorEvals, or

3. The central portal at https://my-ufl.bluera.com

• Guidance on how to provide constructive feedback is available at https://gatorevals.aa.ufl.edu/students/. Students will be notified when the evaluation period opens. Summaries of course evaluation results are available to students at https://gatorevals.aa.ufl.edu/public-results/.

University Honesty Policy

University of Florida students are bound by the Honor Pledge. On all work submitted for credit by a student, the following pledge is required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Student Honor Code and Conduct Code (Regulation 4.040) specifies a number of behaviors that are in violation of this code, as well as the process for reported allegations and sanctions that may be implemented. All potential violations of the code will be reported to Student Conduct and Conflict Resolution. If a student is found responsible for an Honor Code violation in this course, the instructor will enter a Grade Adjustment sanction which may be up to or including failure of the course.

The Honor Pledge

We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honesty and integrity by abiding by the Student 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."

Class Demeanor

Students are expected to arrive to class on time and behave in a manner that is respectful to the instructor and to fellow students. Please avoid the use of cell phones and restrict eating to outside of the classroom. Opinions held by other students should be respected in discussion, and conversations that do not contribute to the discussion should be held at minimum, if at all.

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

Campus Resources:

This course complies with all UF academic policies. For information on those polices and for resources for students, please see https://syllabus.ufl.edu/syllabus-policy/uf-syllabus-policy-links/

Honors Program, 201 Walker Hall, 352-392-1519

Quick questions for an Honors advisor? Email advisor@honors.ufl.edu

Need an Honors advising appointment? Schedule via Microsoft Bookings: https://bit.ly/ufhonorsadvising