Welcome to Stats 100A(3)

Welcome to our learning community. We are looking forward to meeting you and working with you in your training to become a decision maker and consumer of information that wisely accounts for and quantifies chance. We invite you to read this syllabus carefully and be a frequent visitor to our bruinlearn web site as we journey together.

- **Professor:** Dr. Juana Sanchez, Ph.D., jsanchez@stat.ucla.edu, http://directory.stat.ucla.edu/faculty/single-page/?smid=159-**Please, use the Inbox in Bruinlearn to email me.**

  I have been teaching probability since I arrived to UCLA in 1998. I enjoy very much teaching this course. Throughout my research in applied Statistics, there has not been a topic (whether it is business R&D, vertical integration in the chicken industry, genetic susceptibility to breast cancer, blood glucose in diabetes, education, or other) in which probability has not played a major role in making sense of the data and making good decisions. I expect that learning in this course will take place through practice, discovery, collaboration and conversations with our learning community about the many uses of the basic theorems and building blocks of probability, random variables and their probability distributions,expectations and functions thereof. As the catalog says, this is a P/NP or letter grading class.
- **Prerequisites** for this class are multivariate calculus (32B) and basics of matrix algebra. (33A) Some knowledge of R would be a plus, but it is not a prerequisite. We will teach you just what you need of R.
- All course deadlines and times are in **Pacific Standard Time**, the time in Los Angeles.
- **Our course management system** is Bruinlearn at https://bruinlearn.ucla.edu/courses/133166.
- **Start the course with the "Getting Ready" module** but **read first the Course Overview module** for additional details on the course requirements and organization.
- We will have as holidays Memorial Day Holiday (May 30).
- **Dr. Sanchez's Lectures for this class are asynchronous and pre-recorded** and you will find them in our Canvas course site, in each of the modules, starting with "Getting Ready."
- **Dr. Sanchez's live Zoom office hours:** Several hours of the week are designated for you to meet flexibly live with Dr. Sanchez to discuss course content if needed via synchronous Zoom office hour times on: W 3-4 PM; R 10-11 PM, F: 4-5 PM. But if you need at other times via Zoom, you may email Dr. Sanchez via Bruinlearn's inbox to make an appointment.
- **Dr. Sanchez's email policy**: Please, use the Inbox in Bruinlearn. You can expect a response within 24 hours on M-F, longer during weekends. If using my regular email (not recommended) please indicate course (100A(3)) and make sure your full name is in the body of the email.

Welcome to TA sessions

- **TA:** Stephen Smith, Ph.D. Student, UCLA Department of Statistics, stephensmith13424@gmail.com . Please, email the TA via the **Inbox in Bruinlearn**.
- **: TA sessions can be found in each module's TA page:** The live Zoom discussion sessions are synchronous every Friday at 8:00 AM for Dis 3A and 9:00 AM for Dis 2B, if you can attend. During discussion sessions, quizzes embedded in the lectures, examples similar to the hardest problems in the homework and weekly assignments will be discussed in an interactive atmosphere. The sessions will be recorded and the recording will be posted after the session. If you can not make it, watch the videos and participate as much as you can in the google doc if there is one that the TA will post in the TA session page in each week's module.
- **TA office hours:** Zoom synchronous office hours on W, F 10-11 AM.

Community Expectations

Our campus resides on what was historically the homeland of indigenous peoples who were dispossessed of their land. We acknowledge the Gabrielino/Tongva peoples as the traditional land caretakers of Tovaangar (the Los Angeles Basin and So. Channel Islands). As a land grant institution, we pay our respects to the Honuukvetam (Ancestors), Ahiihirom (Elders) and Eyoohiinkem (our relatives/relations) past, present and emerging.

Statistics and Probability are home for all individuals that are willing to be part of this community and is enriched by diversity in the student body. We are guided by the UCLA's Office for Equity, Diversity, and Inclusion, which provides resources, events, and information about current initiatives at UCLA to support equality for all members of the UCLA community. I hope that you will communicate with me or your TA if you experience anything in this course that does not support an inclusive environment, and you can also report any incidents you may witness or experience on campus to the Office of Equity, Diversity, and Inclusion on their website `https://equity.ucla.edu`

Textbook and integrated active learning materials(both required)

- **Required textbook: Probability for Data Scientists, Juana Sanchez, Cognella, 2020.**
- Also required are the **Active Learning Materials** offered by Cognella (free with the purchase of the textbook but they can also be purchased separately). The active learning materials are the within and end of chapter exercises from the required textbook.
- Purchase from the publisher's student store, `https://store.cognella.com/changenumber` at discounted price using the email address that is associated with your Canvas login.
- Please, **view the Pages in the Course Overview Module of our course web site referring to the textbook and the active learning materials for more details.**
- Quizzes and Review assignments are done in the Active learning site of the book's publisher, which can be purchased independently of the textbook or bundled with the textbook.
- The campus textbook store will also sell the book (at a slightly higher price), and that is another venue for you to purchase it.**The SEL library on campus has reserve copies of the textbook, but not the active learning.**
- It is recommended that you do not use old books, particularly if used in 2019 and Winter 2020, as they had a few typographical errors that could be confusing.
- **If you need help email orders@cognella.com or call 858-552-1120 x503.**
  See also the **help file in the Active Learning Folder of the Course Overview Module in our course web site.**
- There are a few copies of the textbook on Reserve at the Science and Engineering Library.

Who to contact and for what

- Enrollment: Use the UCLA Message Center `http://statistics.ucla.edu/` for questions about enrollment.
- Cognella's Active learning access problems after the professor has opened an activity: check the FAQ in the "Accessing Active Learning Materials" page in this Course's Overview Module, and if that does not help, contact orders@cognella.com or call 858-552-1120 x503
- Textbook purchase: Information is at: "Required textbook" in the Overview Module.
- Course content and assessments: Professor or TA (expect an answer within 24 hours Monday to Friday between 8 and 6 PM, longer if during weekends or holidays.)

- **Stat 100A Administrative matters of the course (Canvas web site, personal matters, grading, course requirements, deadlines,due dates, etc)**: Dr. Sanchez (expect an answer within 24 hours Monday to Friday, longer on weekends. Please, use the Inbox in Bruinlearn to email me.

Assessment, milestones and deadlines

- **Modules content:** Watching Dr. Sanchez' greeting and lecture videos and supplementary videos, textbook reading, and material found in the modules is required. They will appear in assessments and are needed in your training. They are carefully selected to make you a great practitioner of probability.
- **Quizzes in the professor's lecture videos** are not graded but their content will be subject to assessment elsewhere. They will be discussed during the TA sessions. Answer them before Thursday 11:55 PM.
- **Weekly formative review assignments in Cognella:** (10% of final grade) done in Cognella Active Learning due on Friday before 11:55PM, guided. Two attempts. Grade is the average. Not timed. The lowest review assignment score of the quarter will be dropped.
- **Biweekly summative quiz** Posted Friday at 8:00 AM approximately, due on Saturdays before 11:55 PM (20% of final grade). Not timed. One attempt. Done in Cognella Active Learning. The lowest quiz score will be dropped.
- **3 to 4 Homeworks** (25% of final grade). The lowest homework score will be dropped.
- **Some graded discussions**, reflections, or course activities not part of the above categories as needed for collaboration and group work. (5%).
- **Midterm** (15%). Exam time window: Posted April 29th and must be submitted before 8 AM on May 2nd. Within the time window you will have 4 consecutive hours to do the exam.
- **Final exam**: (25%). Exam time window: Posted on June 3rd, 8:00 AM and must be submitted before June 6th, 8:00 AM. Within that time window you will have 4 consecutive hours to do the exam.
- Your grade will be determined as follows: A+ 98-100; A 95-97; A- 90-94; B+ 88-89; B 82-87; B- 80-81 C+ 78-79; C 72-77; C- 70-71; D+ 68-69; D 62-67; D- 60-61; F Below 60; P (C or better); S (B or better) The scale will be adjusted at the discretion of the professor.
- **Note: some due dates could be changed by the professor when there are exams.**
- **Note: there are no makeups for any of the activities.Consult with Dr. Sanchez early in the quarter if you have questions about this. Make sure you read carefully the instructions for each activity.**

Academic Integrity and Class Policy

- **Conduct.** As a student and member of the University community, you are here to get an education and are, therefore, expected to demonstrate integrity in your academic endeavors. All students must uphold University of California Standards of Student Conduct as administered by the Office of the Dean of Students `http://www.deanofstudents.ucla.edu/individual-student-code` Students are subject to disciplinary action for several types of misconduct or attempted misconduct, including but not limited to dishonesty such as cheating, multiple submission, plagiarism, or knowingly furnishing false information.
- **Students needing academic accommodations based on a disability** must contact immediately the Center for Accessible Education (CAE) at (310)825-1501 or present in person at Murphy Hall A255 at the beginning of first week of classes. As the professionals delegated authority from the campus to determine reasonable disability accommodations, CAE will assess all requested accommodations and communicate appropriately with faculty. After you have contacted CAE, they will contact the professor. But you should also let the professor know that CAE will be in touch. For more information visit www.cae.ucla.edu

Title IX
Advocacy and Confidential Services

Please note that Title IX prohibits gender discrimination, including sexual harassment, domestic and dating violence, sexual assault, and stalking. If you have experienced sexual harassment or sexual violence, you can receive confidential support and advocacy at the CARE Advocacy Office for Sexual and Gender-Based Violence, 205 Covel Commons, Los Angeles, CA, 90095, care@careprogram.ucla.edu, (310) 206-246 5. Counseling and Psychological Services (CAPS) provides confidential counseling to all students and can be reached 24/7 at (310) 825-0768.

Reporting and Non-confidential Services

Your professor is required under the UC Policy on Sexual Violence and Sexual Harassment to inform the Title IX Coordinator should the professor become aware that you or any other student has experienced sexual violence or sexual harassment. In addition, You can also report sexual violence or sexual harassment directly to the University's Title IX Coordinator, 2255 Murphy Hall, titleix@equity.ucla.edu , (310) 206-3417. Reports to law enforcement can be made to UCPD at (310) 825-1491.

Course content by modules

You must access the modules in Bruinlearn and the pages within the module for details and access to these activities
Subject to change at the discretion of Dr. Sanchez. All items in the modules are required, unless otherwise indicated. Some of these readings may be modified or more added at the discretion of Dr. Sanchez

(1) **Getting Ready Module-week 1**

- "What is Probability for" Dr. Sanchez's pre-recorded video
- Canvas discussion assignment: Tell the class about you
- Gradescope quiz: Are you ready? Self-check
- Week's supportive material for reflection:
  - "What is Probability For?" by Aldous Husley.
  - Why is probability so important in machine learning?
  - "If you say Something is likely, how likely do people think it is? Andrew Mauboussin and Michael J. Mauboussin
  - App "Randomness and the appearance of pattern" by Richard Lowry.
  - Treatment and control group- Randomize using the Rossman/Chance app

(2) **Module week 1** Early history and main building blocks of probability

- Week 1 overview and learning objectives. Just-in-time video by Dr. Sanchez.
- Week 1 lectures:
  - Overview of lectures
  - Lecture: Origins of the mathematical theory of probability
  - Mathematical prerequisites external review videos: on sets to prepare students for the use of sets in probability. Supplemented with applet on Venn diagrams illustrations.
  - Lecture: Building blocks of modern probability: Sample Space and events
  - Lecture: Building blocks of modern probability: probability function
  - Lecture: Partitions - Learning glass lecture.
- Week 1 Synchronous Activities with the TA in Zoom.
- Week 1 Synchronous Zoom office hours with Dr. Sanchez
- Week 1 Synchronous Zoom office hours with TA

- Week 1 review assignment in Cognella
- Homework
- Week's supportive material for studying and reflection:
  - Chapter 1 textbook
  - External tutorial videos on sets
  - Chapter 2 textbook
  - Chapter 3 section 1 textbook
  - App to calculate probability of sums of fair and unfair dice
  - App with Venn diagram illustrations
  - Probability song.
  - "Diagnostic Errors in Tuberculous Patients: A Multicenter Study from a Developing Country."Links to an external site.
  - "Pulmonary tuberculosis as differential diagnosis of lung cancer."

(3) **Module 2- Week 2** Probabilities for a whole population versus probabilities for subgroups od the population.

- Week 2 overview and learning objectives and wrap up of last week. Just-in-time video by Dr. Sanchez.
- Week 2 lectures:
  - Overview of lectures.
  - Lecture: Making decisions. Conditional probability, law of total probability, Bayes theorem.
  - Lecture: Independence and applications in reliability theory
  - Lecture: sampling part 1
  - Lecture: sampling part 2- Urn models, binomial and hypergeometric probabilities
  - Guest Lecture: Judgments under uncertainty, by Maureen Gray, Psychology Department, UCLA, supported by selected articles on probability in Psychology.
- Reception in Gather Town on April 5th, 2 PM
- Week 2 Synchronous Activities with the TA in Zoom.
- Week 2 Synchronous Zoom office hours with Dr. Sanchez
- Week 2 Synchronous Zoom office hours with TA
- Week 2 Review assignment in Cognella
- Week 2 Quiz (Cognella)
- Homework
- Reading and other supportive material
  - Chapter 3, Sections 3.4, 3.5, 3.6, 3.3. of the textbook,
  - Chapter 8 of Horgan's book for reliability
  - Chapter 4.
  - Apps: (i) Treatment and control group- Randomize using the Rossman/Chance app; (ii) Conditional probability app; (iii) Sampling words; (iv) ASA's how well do you know data producing agencies in the U.S.
  - External videos: (i) Understanding the main probability calculations in artificial intelligence; (ii) Conditional probability explained; (iii) Applications of Bayes theorem in medicine.
  - Articles: (i) The Prosecutor's fallacy; (ii) False-positives in Traffic crashes; (iii) Example of survey on urban American indian. (iv) Inferences on Testosterone Use Among Athletes and Statisticians Introduce Science to International Doping Agency (for TA session); (v) Statistics in the courts. Incorrect probabilities (homework).
  - Guest lecture's articles: (i) Big data in Psychology; (ii) Combining data science and psychology.
  - Song

(4) **Module 3- Week 3** Compressing information in sample spaces with random variables.

- Week 3 overview and learning objectives and wrap up of last week. Just-in-time video by Dr. Sanchez.

- Week 3 lectures:
  - Overview of lectures.
  - Tutorial Lecture in learning glass: The summation operator.
  - Lecture: Univariate discrete random variables
  - Lecture: Univariate continuous random variable
  - Lecture: Cumulative distribution functions and percentiles
  - Guest Lecture: Applications of probability in Political Science, by Bruce Tsai, Political Science Department, UCLA.
- Week 3 Synchronous Activities with the TA in Zoom.
- Week 3 Synchronous Zoom office hours with Dr. Sanchez
- Week 3 Synchronous Zoom office hours with TA
- Week 3 review assignment in Cognella
- Homework
- Student's feedback requested.
- Reading and other supportive material
  - Textbook Chapter 5, Sections 5.1, 5.2, 5.3, 5.12
  - Textbook Chapter 1, Box 1.2, p.9
  - Textbook Chapter 7, Sections 7.1, 7.2, 7.3
  - Articles: (i) Benford's law and COVID -19 data.; (ii) Migration and Demand for Transnational justice (from guest speaker). (iii) The Weibull distribution; (iv) The Gamma distribution ; (v) Our brains sample data from probability distributions.
  - External videos: (i) On the convention used for continuous random variables.; (ii) MAxwell-Boltzman distribution.
  - Apps to calculate probabilities.

(5) **Module 4- Week 4** Uses of discrete and continuous probability models in Statistics.

- Week 4 overview and learning objectives and wrap up of last week. Just-in-time video by Dr. Sanchez.
- Week 4 lectures and supportive material:
  - Overview of lectures.
  - Lecture: Log normal model and it fitting to data on radon in Minnesota households
  - Lecture in learning glass: Expectations of functions of discrete random variables part 1.
  - Lecture in learning glass: Expectations of functions of discrete random variables part 2: applications to decision problems with discrete random variables.
  - Lecture in learning glass: Expectations of functions of discrete random variables part 3: When the random variable is one of the families of distributions studied.
  - Lecture in learning glass: Expectations of functions of discrete random variables part 4: Important result involving variance of a random variable.
  - Lecture: Fitting the Poisson model to baby boom data. Using the Chi-square distribution to determine goodness of fit.
  - Guest Lecture: Modern probabilistic models in artificial intelligence, by Dr. Ruiqi Gao.
- Week 4 Synchronous Activities with the TA in Zoom.
- Week 4 Synchronous Zoom office hours with Dr. Sanchez.
- Week 4 Synchronous Zoom office hours with TA.
- Week 4 review assignment in Cognella
- Week 4 Quiz (Cognella)
- Homework
- Reading and other supportive material

  - Chapter 5 in the textbook, Sections 5.4, 5.14, 5.15, 5.17
  - Chapter 7 in the textbook, Sections 7.3, 7.10, 7.16
  - Chapter 10 in the textbook, Section 10.2
  - External videos: (i) Why is probability so important in Machine Learning? (ii) How Bayesian statisticians use probability models as compared with frequentists statisticians.
  - Articles:(i) Death by horse kick; (ii) Modern-media replication of historical applications; (iii) Article on generative models in AI suggested by Dr. Gao's guest lecture; (iv) On NHANES.
  - Apps to calculate probabilities.

(6) **Module 5- Week 5** Uses of discrete and continuous probability models in Statistics.

- Week 5 overview and learning objectives and wrap up of last week. Just-in-time video by Dr. Sanchez.
- Week 5 lectures and supportive material:
  - Overview of lectures.
  - Lecture: The Binomial model for Binary outcomes with an emphasis on using it to model data
  - Lecture: The geometric model with emphasis on using it to model data.
  - Lecture: The negative binomial model with emphasis on using it to model data.
  - The Gaussian distribution (supplemented with app)
  - Guest Lecture: Using the binomial when doing binomial tests for a repeated measures data set. By Dr. Rob Weiss, Department of Statistics.
- Week 5 Synchronous Activities with the TA in Zoom
- Week 5 Synchronous Zoom office hours with Dr. Sanchez.
- Week 5 Synchronous Zoom office hours with TA.
- Week 5 review assignment in Cognella (Due on Thursday)
- Dr. Sanchez's live zoom review session during office hours. Recorded.
- Reading and other supportive material
  - Textbook, Chapter 5, Sections 5.7-5.13
  - Textbook, Chapter 7, Section 7.9
  - Articles: (i) The Binomial and Hypergeometric in Jury selection; (ii) The Hypergeometric in the Anthrax Spores case in 2001; (iii) On network attacks prevention.
  - Apps and simulator for the binomial simulator and the Gaussian

MIDTERM: Time Window: February 4, 8:00 AM to February 7th, 8:00AM
Covers material up to and including Week 5

(7) **Module 6- Week 6** Models for more than one random variable.

- Week 6 overview and learning objectives and wrap up of last week. Just-in-time video by Dr. Sanchez.
- Week 6 lectures and supportive material:
  - Overview of lectures.
  - Lecture: Bivariate discrete random variables.
  - Lecture: Bivariate discrete conditional distributions
  - Lecture: Bivariate continuous random variables
- Week 6 Synchronous Activities with the TA in Zoom
- Week 6 Synchronous Zoom office hours with Dr. Sanchez.
- Week 6 Synchronous Zoom office hours with TA.
- Week 6 review assignment in Cognella
- Week 6 Quiz (Cognella): Due Saturday

- Homework
- Reading and other supportive material
  - Textbook, Chapter 6, sections 6.1-6.4
  - Textbook, Chapter 8, Section 8.1-8.4,
  - Article: Cheating partners
  - Apps: (i) Guess correlation; (ii) Visualize bivariate normal and regression line and simulator for the binomial simulator and the Gaussian

(8) **Module 7- Week 7** Uses of discrete and continuous probability models in Statistics.

- Week 7 overview and learning objectives and wrap up of last week. Just-in-time video by Dr. Sanchez.
- Week 7 lectures and supportive material:
  - Overview of lectures.
  - Lecture: Correlation when the random variables are discrete
  - Lecture: Conditional density functions for continuous random variables
  - Lecture: Bivariate continuous random variables, their correlation
- Week 7 Synchronous Activities with the TA in Zoom
- Week 7 Synchronous Zoom office hours with Dr. Sanchez.
- Week 7 Synchronous Zoom office hours with TA.
- Week 7 review assignment in Cognella
- Homework
- Reading and other supportive material
  - Textbook, Chapter 6, sections 6.5-6.10
  - Textbook, Chapter 8, Section 8.4-8.9
  - Article: "Cardiovascular disease in a population-based sample of Transgender and Cisgender adults"
  - Apps: (i) Simple linear regression; (ii) visualizing correlation; (iii)

(9) **Module 8- Week 8** The probability laws that drive social media, insurance and good results in Statistics.

- Week 8 overview and learning objectives and wrap up of last week. Just-in-time video by Dr. Sanchez.
- Week 8 lectures and supportive material:
  - Overview of lectures.
  - Lecture in learning glass: Expectation of linear functions of several random variables. Part 1.
  - Lecture in learning glass: Expectation of linear functions of several random variables. Part 2.
  - Lecture: Central Limit theorem
  - Lecture: Law of Large Numbers (Law of Averages)
  - Lecture: Chebyshev's and Markov's theorems
- Week 8 Synchronous Activities with the TA in Zoom.
- Week 8 Synchronous Zoom office hours with Dr. Sanchez.
- Week 8 Synchronous Zoom office hours with TA. F 2:00 PM- 3:00 PM.
- Week 8 review assignment in Cognella.
- Week 8 Quiz (Cognella).
- Homework
- Reading and other supportive material
  - Section 5.5 in the textbook
  - Section 7.4 in the textbook
  - Section 6.7 in the textbook

  - Section 8.7 in the textbook
  - Chapter 9 in the textbook
  - External videos: (i) Bunnies, dragons and the normal world (animation); (ii) several Informal videos on the law of large numbers (in insurance, in sales, with random numbers).
  - Dr. Sanchez's demo of CLT with Rossman/Chance apps

(10) **Module 9- Week 9** Mutinomial distribution and joint distributions of many random variable

- Week 9 overview and learning objectives and wrap up of last week. Just-in-time video by Dr. Sanchez.
- Week 9 lectures and supportive materials.
  - Overview of lectures.
  - Lecture: Multinomial distribution for non-binary outcomes.
  - Lecture: Joint distributions and how they are used in Statistics
  - Lecture: Brief overview of markov models.
  - Guest lecture: The Law of Large Numbers, Social media and insurance.
- There is no TA session due to Thursday being Thanksgiving data.
- Week 9 Synchronous Zoom office hours with Dr. Sanchez.
- Week 9 Synchronous Zoom office hours with TA.
- Week 9 review assignment in Cognella
- Homework
- Canvas quiz: self-reflection on learning.
- Reading and other supportive material
  - Textbook, Chapter 6, Section 6.9
  - Textbook, Chapter 8, Section 8.8
  - Textbook, Chapter 9, sections 9.5.4-9.5.5

(11) **Module 10-Week 10** Review with student-produced content

- Week 10 overview and learning objectives and wrap up of last week. Just-in-time video by Dr. Sanchez.
- Week 10 lectures and supportive materials.
  - Overview of lectures
  - Lecture: short student-produced videos of course content.
  - Lecture:short student-produced videos of course content
  - Lecture: short student-produced videos of course content.
- Week 10 Synchronous Activities with the TA in Zoom.
- Week 10 Synchronous Zoom office hours with Dr. Sanchez.
- Week 10 Synchronous Zoom office hours with TA.
- Week 10 review assignment in Cognella : Due Thursday before 11:55 PM.

Appendix to course content -Probability concepts covered in the Textbook Chapters that students will use to study.

(a) Chapter 1 of Sanchez (2020). Introduction to the beginnings of mathematics in probability.

(b) Basic Concepts of Probability:Experiments, events, sample space. Algebra of sets as algebra of events. Chapter 2 of Sanchez (2020)

(c) Axioms and properties of Probability. Addition rule, complement rule, product rule, and other theorems of probability. Conditional Probability and Independence. Product rule. Applications on rules learned to Reliability. Simulation with random numbers. Chapter 3 of Sanchez (2020)

(d) Sampling and repeated experimentation. Chapter 4 of Sanchez (2020).

(e) Univariate Discrete Random variables. Constructing the distributions of random variables directly from the sample or outcome space of the experiment. The probability mass function. Summarizing a discrete Probability mass function model: calculating probabilities, expected value, variance of a discrete random variable; expectations and variance of functions of a random variable, moment generating function. Expectations and variance of a sum of iid random variables. Chapter 5 of Sanchez (2020)

(f) Families of univariate discrete random variables. Applying expectation, variance and other learned concepts to these random variables:The Bernoulli, Binomial, the Poisson, the Geometric, Negative Binomial, Hypergeometric discrete random variables. Chapter 5 of Sanchez (2020)

(g) Bivariate discrete random variables. Joint, marginal and conditional distributions. Joint, marginal and conditional probabilities, expectations and variances. Covariance and Correlation. Independence of two random variables. Expectations and variances of linear combinations of bivariate random variables. The multinomial distribution. Chapter 6 of Sanchez (2020)

(h) Univariate Continuous Random Variables. The density function. Summarizing a density function: calculating probabilities, expected value, variance of a continuous random variable; expectations and variance of functions of a continuous random variable, moment generating function. The cumulative distribution function. Percentiles. Expectation and variance of sums of iid random variables. The exponential, Gamma, Normal, Weibull and other families of continuous random variables, among others will be used to illustrate the concepts .Normal approximation to the Binomial. Chapter 7 of Sanchez(2020).

(i) Bivariate continuous random variables. Joint, marginal and conditional distributions. Joint, marginal and conditional probabilities, expectations and variances. Covariance and Correlation. Independence of two random variables. Expectations and variances of linear combinations of bivariate random variables. Proofs of results on linear combinations of several random variables. The multivariate normal distribution. Chapter 8 of Sanchez (2020)

(j) The Central Limit Theorem about the normality of sums and averages of iid random variables. The law of averages proved with Chebychev's theorem. Chapter 9 of Sanchez (2020)

(k) Putting it all together. Challenging problems and applications where students must decide which of the methods and concepts studied help solve problems.

Course Learning Goals

Some students come to this course thinking that this is a course in Probability and Statistics. If that was the case, the course would be called "Introduction to Probability and Statistics." Stat 100A is the Probability part of the theoretical sequence in the Statistics Department. To complete your education in Statistics, you would have to take the following courses, Stat 100B and 100C, and preferably an applied course or two in the 101 sequence, and courses in the 102, computational, sequence. But some of you will not take those courses. Does that mean you will not get a flavor of data analysis and data science? No. In Stat 100A you will learn and practice the use of probability to understand data and to understand why probability is so important in statistics and data science, besides being so important in decision making in your field of expertise. Probability is a fundamental prerequisite for the understanding of statistical findings and for making progress in the more popular machine learning and artificial intelligence domains that rule our lives today.

By the end of this course:

(a) Students will be critical consumers of estimates of probabilities reported in popular media, recognizing whether reported results reasonably follow from the study and analysis conducted.

(b) Students will learn to anticipate how probability models and the expectation operator are used by Statisticians to do statistical inference.

(c) Students will recognize and be able to explain the central and natural role of variability that results from chance alone and will be able to discern how authors acknowledge it in empirical studies with data.

(d) Students will recognize and be able to appreciate the central role of randomness in designing studies, sampling, drawing conclusions, making decisions, and statistical and mathematical computation.

(e) Students will become aware of the distinction between empirical distributions and the generalizations that probability theory provides to help make sense of those empirical distributions.

(f) Students will demonstrate an understanding of basic ideas of probability in a variety of settings.

(g) Students will demonstrate an awareness of ethical issues associated with sound applications of probability.

(h) Students will understand how high tech companies, insurance companies and others use limit theorems and laws of averages of probability to guarantee at least average profits.

Check the course Math 170 in the Math Department. It could be an interesting course for you if you are going to continue a mathematics career.

Specific learning outcomes

(1) Will odentify types of variables that arise from very diverse random experiments.

(2) Will use the axiomatic approach to probability and derived theorems to calculate the appropriate probabilities of events using product rule, Bayes theorem, law of total probability, addition rule, complement rule, and other basic theorems.

(3) Will reproduce and prove using the concept of partition basic theorems of probability.

(4) Will describe, interpret and apply probability distribution models for a diverse array of discrete and continuous random variables.

(5) Will calculate probabilities, expectation, variance, moment generating function, other moments for a diverse array of random variables and will apply these concepts to several contexts.

(6) Will calculate probabilities in the context of random variables results using the addition rule, product rule, complement rule, total probability, conditional probabilities, Bayes theorem.

(7) Will use expectations of functions of the random variables, conditional expectations of functions of the random variables and other expectations to make decisions and draw conclusions.

(8) Will calculate expectations and variances of sums, averages and will calculate joint probabilities, applying those concepts to several contexts.

(9) Will experiment and simulate phenomena to appreciate the role of empirical approximations to probabilities and important theorems such as the Law of Large Numbers and the Central Limit theorem.

(10) Will construct and manipulate joint bivariate distributions, conditional and marginal distributions and their corresponding expectations, and will draw conclusions on applied questions using those.

(11) Will be able to apply the theory, simulation and calculations to reliability in industry and simple networks.

(12) Will demonstrate, communicate and translate the information on applications of probability to peers.

(13) Will be able to distinguish among probability distributions of one random variable, of two random variables, of a sum of random variables, of the average of random variables, of many random random variables. Will be able identify when each of those applies in a given context.

(14) Will distinguish between situations where independence can be assumed and situations where it can not be assumed.

(15) Will communicate probability statements in the context of its applications, both with technical and non-technical language.

(16) Will study uses of probability models in statistical inference.

(17) Students will gain enough proficiency in the manipulations of the expectation operator and theorems of probability to make a smooth transition to the study of Mathematical Statistics.

Some tips about learning, group work, reading and thinking ahead and study habits

- Our aim with all activities, pre-recorded lectures, supplementary readings and videos, review assignments, quizzes, discussions, collaborations, exams and TA sessions is to acquire enough breadth and depth of the subject to incrementally satisfy the course goals. All students with the prerequisites can achieve that. Communicating and speaking about the subject matter, reading, summarizing on your own, thinking of ways to express the concepts, and preparing daily to asses what you can do on your own, is an important component to achieve our learning goals.
- Talking about what we learn, in our own language, has been found to improve learning and retention. That is why you are required at times to work with students in the class and to participate in group discussions, debates, interviews, and other community online activities. Learning takes place in society,we are not isolated. Talking about what we learn enhances retention and comprehension. This particularly helps become more familiar with the jargon of probability. Writing your thoughts and methods has the same effect. Asking questions also. Expressing what you learn by several means, such as videos , audios, a drawing, a concept map, helps you and others communicate with each other.

- Your active engagement in your learning, organized studying, reviewing the notes you take while watching videos, doing readings, going over the pre-recorded lectures, connecting past and new material your own way, as well as self-assessment and good study habits have been found to be very important factors in students' success in their academic endeavors. Everything in each module is intended to help all of you become gradually feel more and more comfortable thinking and speaking like those in the field of probability.
- Research has found that students who organize and write the required material in their own way, have questions and seek answers about what they do not understand, and keep up to date with the course content, think about what is and is not clear, and solve their doubts sooner by asking, are more successful learners. Talk to each other about your study habits. Review, record, reflect, report.
- By working in groups and talking to the class community about the material being learned all win. Working on a problem together, preparing a concept map, trying to understand conflicting arguments, and pros and cons of actions, helps retention of the material learned.