Shanghai University of Finance & Economics

2020 Summer Program

STAT 400 Probability Theory

Course Outline

Term: June 1 – June 26, 2020

Class Hours: 8:00-9:50 (Monday through Friday)

Course Code: STAT 400

Instructor: Professor Vadim Olshevsky

Home Institution: University of Connecticut

Office Hours: TBA and by appointment

Email: olshevsky@gmail.com

Credit: 4

Class Hours: This course will have 52 class hours, including 32 lecture hours, professor 8 office hours, 8-hour TA discussion sessions, 4-hour review sessions.

Course Description: Introducing probability and statistical inference. The course has a prerequisite of differential and integral calculus. We will use the textbook "A first course in Probability" by Sheldon Roth, 10th edition.

Course Objectives: A student who satisfactorily completes this course will be able to:

- Calculate the expected value and variance of a continuous random variable.
- Compute probabilities for Uniform random variables.
- Calculate probabilities given a Normal density.
- Calculate the shortest intervals given a Normal density and the probability of the interval.
- Calculate parameter values for a normal density given probabilities over some intervals.
- Use Normal approximation to approximate Binomial probabilities.
- Calculate probabilities for exponential distribution.
- Interpret the memoryless property of an exponential random variable.
- Apply the memoryless property of an exponential random variable to derive the hazard rate

function.

- Derive the distribution of a function of a random variable given probability density function or probability mass function of the random variable.
- Calculate probabilities for multiple random variables based on joint probability functions.
- Calculate marginal distributions from joint distributions.
- Calculate joint density functions from Joint cumulative distribution functions or Vice verse.
- Solve problems using the properties of independent random variables.
- Calculate the joint probability distribution of functions of random variables.
- Calculate the probability density functions or cumulative distribution functions for sums of independent random variables.
- Calculate the conditional probability mass function and conditional probability distribution function for discrete random variables.
- Calculate the conditional probability density function and conditional probability distribution function for continuous random variables.
- Using the property of expectation of sums of random variables to solve expected value problems or calculate probabilities.
- Calculate expectation and variance by calculating the moments of the number of events that occur. • Calculate covariance of random variables.
- Calculate expectation by conditional expectation.
- Calculate conditional variance.
- Calculate variance through calculating the expectation of conditional variance and variance of conditional expectation.
- Calculate moment generating functions for either a discrete random variable or a continuous random variable.
- Compute moments of a random variable by differentiating the moment generating function of the random variable.
- Use Markov's inequality to obtain bounds on the probabilities of some events.
- Use Chebyshev's Inequality to obtain bounds on the probabilities of some events.
- Use Chernoff bounds to obtain bounds on the probabilities of some events.
- Solve probability problems for large samples by applying Central limit theorem.
- Apply the weak law of large numbers or the strong law of large numbers to derive behaviour of a random variable which can be expressed as mean of n iid random variables when n is large.

Required Textbooks: A first course in Probability" by Sheldon Roth, 10th edition, 2018, Pearson,

Homework: We will use Pearson My Lab web site for daily homework assignments.

Grading & Evaluation

Attendance and participation: 10%
Homework: 30%
Midterm: 30%
Final: 30%

Grade	Range
A	90-100
B	80-89
C	70-79
D	60-69
F	0-59

Course Schedule

Week1

Monday 1.2 Basic Principle of Counting (Multi- plication Principle, Rule of product), 1.3 Permutations, 1.4 Combinations, 1.2 Basic Principle of Counting (Multi- plication Principle, Rule of product), 1.3 Permutations, 1.4 Combinations.
Tuesday 2.2 Sample Spaces & events, 2.3 Axioms of Probability, 2.4 Simple Propositions, 2.5 Sample Spaces of Equally Likely Events, 2.6 Probability as a Continuous Set Function.
Wednesday 2.7 Probability as a Measure of Belief, 3.2 Conditional Probability.
Thursday 3.3 Bayes Formula, 3.4 Independent Events, 3.5 P(.|F) is a probability.

Week2

Monday 4.1 Random Variables (RVs), 4.2 Discrete RVs, 4.3 Expected Value, 4.4 Expectation of a Function of a RV, 4.5 Variance.
Tuesday 4.6 Bernoulli & Binomial RVs, 4.7 Poisson RVs, 4.9 Expectation of Sums of RVs, 4.10 Cumulative Distribution Functions
Wednesday 5.1 Continuous RVs, 5.2 Expectation and Variance of Continuous RVs, 5.3 Uniform Vs 5.4 Normal Random Variables
Thursday Midterm exam.

Week3

Monday 5.5 Exponential RVs, 5.7 Distribution of a Function of a RV, 6.1 Joint Distribution Functions, 6.2 Independent RVs
Tuesday 6.3 Sums of Independent RVs, 6.7 Joint Probability Distribution of Functions of RVs
Wednesday 6.4 Conditional Distributions (Discrete), 6.5 Conditional Distributions (Continuous)
Thursday 6.5 Conditional Distributions (Continuous)
7.2 Expectation of Sums of RVs, 7.3 Moments of the Number of Events that Occur Nov

Week4

Monday 7.7 Moment Generating Functions, 7.8 Additional Properties of Normal Random Variables
Tuesday 8.2 Markov's Inequality, Chebyshev's Inequality and the Weak Law of Large Numbers, 8.3 The Central Limit Theorem
Wednesday 8.4 The Strong Law of Large Numbers, 8.5 Other Inequalities (One-sided Chebyshev Inequality, Chernoff Bounds)
Thursday Final exam.

Student responsibilities/expectations: The main course material will be presented through lectures. A discussion session, to be held every Friday will offer an opportunity for students to discuss course material and assigned problems with a teaching assistant (TA). Students are advised to keep pace with the course material as it is being presented. Consequently, students should endeavor to attend all class meetings and discussion sessions, be early for class, and spend sufficient time working on assigned homework problems. If for any reason a student misses a class, he/she should endeavor to obtain the notes and learn the missed material before the next class meeting. Students should not hesitate to ask questions or seek additional assistance to ensure that they are staying on pace with the class. Students will be expected to come to class prepared and ready to participate actively. Please, turn off your cell phones and put aside any unrelated material before class begins. Students must be responsible and show respect towards fellow students. Late coming to class or early departure from class meetings will not be allowed.

Examinations: There will be one midterm exam plus one cumulative final exam. The exams will contain problems to solve and definitions, brief explanations of concepts, and proofs.