ECON 502
Economic Statistics
Section M1(39069), TR 8:00-9:20 am, online synchronous
Department of Economics • UIUC
Course Outline Spring 2021

Compass site login page: *https://compass2g.illinois.edu/*

Instructor: Ali Toossi
Office: 205C DKH
Phone: 217-333-6777
E-mail: toossi@illinois.edu
Al the times are in US Central Time Zone.

Lectures: There will be synchronous zoom meetings on TR 8:00-9:20 am. You will be sent a link to the recurring zoom meetings. Although the live zoom meeting will be recorded and uploaded to the course's Compass site, you must participate in the synchronous zoom meeting. If for any reason you are not able to attend, you must contact me for permission not to attend. I will announce additional synchronous meetings if I think they are necessary.

Office hours:

- Send me an email to set up a 20-minute individual appointment during the time slot MW 9:00-10:00 am. I can consider other times if this date/time is not good for you.
- I will announce live Q&A zoom meetings during the semester.

Assistant Instructor (AI):

This course has an assistant instructor (AI). The AI will hold synchronous zoom meetings on Fridays. In these sessions, the AI will review the material covered in class, go over more examples, and answer your questions. Although these sessions will also be recorded and uploaded to the course's Compass site, you must participate in them. If for any reason you are not able to attend, you must contact the AI and get his permission not to attend. For those who are not able to participate, the AI will announce a deadline before the review session for you to submit questions so that they can be answered during the session. The assistant instructor will also hold daily virtual synchronous office hours. You can also request individual appointments as needed.

Lucas Squarize Chagas
Office: 110 DKH
E-mail: chagas2@illinois.edu
Virtual Office hours: MW 7:00-8:00 pm, TR 9:30-8:30 am. You can also set up individual appointments. Lucas will announce later how you can do this.

Virtual Weekly Session: Friday 12:30-1:50 pm

*The first meeting of Friday sessions will be on **Friday January 29**.*

Compass site: You can access the course syllabus, course outline, lecture notes, recorded lectures, assignments, sample exams, and your grades via the compass site created for this course. To login go to this link: https://compass2g.illinois.edu/ I also have created a discussion board on the Compass site. You can post your questions there and either me or Lucas will try to answer you as soon as possible.

Text:
Required: *Mathematical Statistics with Applications* (7th ed.), by Dennis Wackerly, William Mendenhall III, Richard Scheaffer. Cengage Learning.
Note that *eBook* and *rent print book* options are available. Go to:
https://www.cengage.com/c/mathematical-statistics-with-applications-7e-wackerly/9780495110811/

Recommended: *Probability & Statistical Inference* (9th ed.), by Hogg / Tanis / Zimmerman.
https://www.pearson.com/us/higher-education/program/Hogg-Probability-and-Statistical-Inference-9th-Edition/PGM91556.html

Software: You have to do some assignments using Excel and R. You can download the software R at this site: https://cran.r-project.org/. I will post a brief instruction on coding in R on Compass site.

Prerequisite: Having passed an undergraduate course in probability and statistics will help. You should also know *set theory* and be able to do simple *differentiation* and *integration*.

Learning outcomes: After completing this course, you should be able to:

- Demonstrate knowledge and use of probability theory
- Derive estimators for unknown parameters, and compare and evaluate estimators
- Test hypothesis and confidence intervals for unknown parameters
- Demonstrate a basic understanding of computer simulation
- Apply concepts to practical problems and relate them to other coursework and experiences you've had in statistics

Grading: The course grade will be determined as follows:

Homework	20%
Midterm 1	20%
Midterm 2	25%
Final	35%

I will adjust the average determined above to take into consideration the trend of your performance and grades.

Assignments: There will be a required homework assignment approximately every two weeks (7-8 homeworks). Each assignment consists of some problems and an Excel or R project. There will also be some *optional* problems assigned from the book. You do not need to turn in the optional problems, but I strongly recommend that you do them.

I will post the assignments on the course Compass site. You can do your work in whatever program you are comfortable with (e.g., Word) but all solutions must be submitted in PDF

format. You can also complete the assignments on paper, scan them, save them as a PDF file, and submit them. If you choose to do your assignments on paper, they must be completed neatly, professionally, and legibly.

Assignments should contain the following information on the **right-hand corner** of the first page: your name, assignment number, and the date.

Use the following format to name your solution file:

FIRST NAME_ LAST NAME-ASSIGNMENT##(SP21). The symbols ## stand for assignment number.

Please email the PDF file of your solutions to the following email address:
econ502MSPE@gmail.com

For each assignment a deadline will be announced. Any solutions submitted after the deadline will not be graded.

Exams: The class will have two *midterm exams* and *a final exam*. You must complete the exams in a pre-specified time slot that will be announced later. The midterm exams are for one hours thirty minutes and final exam three hours. We will email you the exam just before the time specified for the beginning of the exam. You must submit your completed exam within 10 minutes after the time specified for the end of the exam. The extra 10 minutes is to give you sufficient time to save (or scan) your solution and email it to econ502MSPE@gmail.com. You may be asked to do the exams live via zoom with your video turned on. Any exam submitted after the deadline will NOT be graded. The dates of the exams are as follows:

Midterm 1: Thursday, ***March 4***, During class time
Midterm 2: Tuesday, ***April 8,*** During class time
Final exam: Tuesday, **May 11**, 7:00 pm-10:0 pm

All exams are cumulative. If an extreme circumstance occurs (e.g., illness), notify me prior to the exam and provide appropriate documentation. Otherwise, there will be no make-up exams.

Academic Integrity:

Help: When working on assignments, you may provide help to and/or receive help from any of your fellow classmates. What a great way to learn! However, each student must hand in an independent write-up of each assignment.

Cheating: Copying other student's work for assignments or cheating during exams is not tolerated.

Violations of academic integrity as given in the Code of Policies and Regulations will be taken extremely seriously, and students found cheating in the course (or helping others to cheat) will be penalized according to the Code's guidelines.

The University's full academic integrity policy is available at:
http://studentcode.illinois.edu/article1_part4_1-401.html
Here is an excerpt:

"*Expectations of Students*. It is the responsibility of each student to refrain from infractions of academic integrity, from conduct that may lead to suspicion of such infractions, and from conduct that aids others in such infractions. Students have been given notice of this Part by virtue of its publication. Regardless of whether a student has actually read this Part, a student is charged with knowledge of it. Ignorance is not a defense."

Disabilities: Do you have a documented disability for which you may be requesting an accommodation? To obtain disability-related academic adjustments and/or auxiliary aids, students with disabilities must contact the course instructor and the Disability Resources Educational Services (DRES) as soon as possible. To contact DRES you may visit 1207 S. Oak Street, Champaign, call 333-4603 (V/TTY), or email a message to *disability@uiuc.edu*.

You can access the web site of DRES at https://www.disability.illinois.edu/

Course Outline:

The course outline lists the dates each topic will be covered.
The dates are approximate & could change.

Lecture	Date	Topics Covered
1	January 26	**Chapter 1: What is statistics?** Descriptive & Inferential Statistics Population or Process, Sample Strategies for collecting data
2	January 28	**Chapter 1: What is statistics?** (*Continued*) Types of studies: experimental/Observational Types of Data: Cross section, Time series, Panel Types of Data: Quantitative vs Qualitative **Descriptive statistics:** Quantiles, **Descriptive statistics:** Mean, trimmed mean, Median, mode,
3	February 2	**Chapter 1: What is statistics?** (*Continued*) Variance, CV , MAD, Empirical Rules, Skewness, Kurtosis, JB test for normality
4	February 4	**Chapter 2: Probability** Set theory, random experiments, sample space (Discrete , Continuous); event (simple, compound) Def. of probability=> 3 approaches: 1-probability as proportion of desired to possible outcomes,

		2- probability as relative frequency, 3- axiomatic approach, Using axiomatic approach to derive some results
Monday	**11:59 pm US CT, Feb. 8**	**First Homework Due**
5	February 9	**Chapter 2: Probability** (*Continued*) Assigning probability of event: Sample point method Tools for counting: multiplication rule, permutation, combination
6	February 11	**Chapter 2: Probability** (*Continued*) Binomial & multinomial coefficients examples on counting additive law of probability Conditional probability Multiplicative law of probability Independence & conditional independence of events
7	February 16	**Chapter 2: Probability** (*Continued*) Calculating probability of event: event composition method Using table to solve problems The law of total probability & Bayes' rule
Asynchronously recorded video	**February 16**	**Chapter 2: Probability (*Continued*)** **More examples on Bay's rule** **Simple random sampling** **Random Variable (RV): Definition, Discrete & continuous RV**
8	February 18	**Chapter 3: Discrete random variables** Random variable and its realization P(Y=y) Discrete probability distribution expected value: mean, variance mean & variance of a function of a random variable Examples on expected value and variance
Saturday	**11:59 pm US CT, Feb 20**	**Second Homework Due**
9	February 23	**Chapter 3: Discrete random variables (continued)** Bernoulli experiment & related distributions Bernoulli Distribution

		Binomial Distribution: Definition and formula Binomial Distribution: as sum of Bernoulli random variables, Mean, variance Examples on Binomial Distribution
Asynchronously recorded video	**February 23**	**Chapter 3: Discrete PDF (*Continued*)** **More examples on Binomial** **Hypergeometric** **Geometric** **Negative binomial**
10	February 25	**Chapter 3: Discrete random variables (continued)** Poisson process & Poisson distribution
Tuesday	**11:59 pm US CT, March 2**	**Third Homework Due**
11	March 2	**Chapter 3: Discrete random variables (continued)** Moments around origin and about the mean Moment generating functions Tchebysheff's Theorem
Midterm 1	**Thursday March 4**	**7:50-9:30 am**
12	March 9	**Chapter4: Continuous random variables** Cumulative Distribution function (CDF) Discrete Y: CDF ➔STEP function (right Continuous) Continuous Y: CDF ➔Continuous function Continuous Y: Probability Density Function Relation between CDF & PDF Example on PDF & CDF
13	March 11	**Chapter4: (continued)** Expected value & Variance of Continuous RV The uniform PD Normal PD
Asynchronously recorded video	**March 11**	**Extra examples on Normal & Uniform distributions**
14	March 16	**Chapter4: (continued)** Example on Normal The Gamma PD

		Gamma Special cases: Chi-square, Exponential Memoryless property of Exponential Examples on exponential Beta Distribution
Asynchronously recorded video	**March 16**	**Chapter4:** Relationship between Gamma & Poisson Relationship between Exponential & Poisson Hazard function
15	March 18	**Chapter4: (continued)** MGF for continuous RV Tchebysheff's theorem for continuous RV **Chapter 5: Bivariate PD (discrete)** Joint and cumulative probability distribution Marginal & conditional probability distributions Independent random variables, Expected value of a function of random variables conditional expectations Example on bivariate discrete distributions
Saturday	**March 20**	**4th Homework Due**
16	March 23	**Chapter 5: Bivariate PD (discrete)** Example on bivariate discrete distributions Covariance & Correlation expected value and variance of a linear function Expected value & variance of sample mean
Asynchronously recorded video	**March 23**	**Chapter5:** simple linear regression & Correlation Expected value & variance of sample proportion Law of large numbers for sample mean & sample proportion Bivariate probability distribution (Continuous RVs) Introduction to double integration Example on double integration
17	March 25	**Chapter 5: Bivariate probability distributions (continuous)**

		Joint Distribution function & density function Marginal & conditional probability distributions Independent random variables Expected value of a function of random variables Conditional expectations Example on conditional expectation Law of iterated expectations
Asynchronously recorded video	**March 25**	***Chapter 5: Bivariate probability distributions (continuous)*** **Examples on Bivariate continuous variables and law of iterated expectations**
18	March 30	**Chapter 5: Bivariate probability distributions (continuous)** Bivariate normal **Chapter 6: Functions of random variables (sections 6.1-6.5)** Functions of random variables: 3 methods Distribution function Method Method of Transformations
19	April 1	**Chapter 6: Functions of random variables (sections 6.1-6.5)** Examples on method of distribution and transformation Method of MGFs Examples on Method of MGFs
Asynchronously recorded video	**April 1**	**More Examples on chapter 6**
Asynchronously recorded video	**April 2**	**Chapter 7: Sampling distribution & the CLT** Definition of statistic Definition of sampling distribution Sampling distribution of: sample mean (when population variance is known) sampling distribution of sample variance t-student distribution sampling distribution of sample mean (when population variance is unknown)

		F distribution Sampling distribution of ratio of two sample variances (from two populations) Examples on Sampling Distributions Normal approximation to the binomial Examples on approximation of binomial by standard Normal Central limit theorem Examples on CLT
Asynchronously recorded video	**April 2**	**Chapter 8: Estimation (sections 8.1 to 8.4)** Point estimation, Estimators Properties: Bias, mean square error **Chapter 9: More on point estimates** Relative efficiency Cramer-Rao theorem (page 448) Examples on Cramer-Rao
20	April 6	**Chapter 9: More on point estimates** Review of material on chapters 7 & 8 covered in asynchronously recorded videos consistency sufficiency
Tuesday	**April 6**	**Fifth Homework Due**
Exam 2	**Thursday April 8**	**7:50 am -9:30 am**
	Tuesday April 13	**BREAK DAY**
21	April 15	**Chapter 9: methods of estimation** Distributions of Exponential Forms (DEF) DEF & sufficient statistics DEF & Minimum Variance Unbiased Estimators (MVUE) Estimation method: moments Examples on Method of moments,
Asynchronously recorded video	**April 16**	**Chapter 9:** More explanation & example on sufficiency
22	April 20	**Chapter 9: methods of estimation** Estimation method: maximum likelihood Examples on Method of maximum likelihood **Chapter 8 revisited** Confidence intervals large sample cl for the mean and proportion

Asynchronously recorded video	**April 21**	**Chapter 9:** Solving examples on: "factorization criterion", "distribution of exponential forms", "application of Lehman-Scheffe theorem" & "method of moments"
23	April 22	**Chapter 8 revisited** Small sample confidence interval for: the mean & difference of means Confidence interval for the variance **Chapter 10: Hypothesis Testing** Introduction to Hypothesis Testing *How to construct RR* Type I and Type II errors Alpha, beta and Power of tests Power function
Asynchronously recorded video	**April 23**	**Chapter 9:** **Example on MLE** **Chapter 8 (revisited):** **Examples on large sample confidence intervals**
Friday	**April 23**	**Sixth Homework Due**
24	April 27	**Chapter 10:** **Review of the following concepts** Type I and Type II errors Alpha, beta and Power of tests Power function *How to construct RR*
Asynchronously recorded video	**April 28**	**Chapter 10: Hypothesis Testing** *Simple vs composite hypothesis Neyman Pearson Lemma* *Examples on N-P Lemma* Uniformly Most Powerful Tests
Asynchronously recorded video	**April 28**	**Chapter 10: Hypothesis Testing** Example on Power Function *Likelihood ratio tests with an example*
25	April 29	**Chapter 10: Hypothesis Testing** Example on Neyman-Pearson Lemma Example on Power Function *Likelihood ratio tests*
Asynchronously recorded video	**April 30**	**Chapter 10: Hypothesis Testing** *Example on Likelihood ratio tests* The recipe for doing large sample tests
26	May 4	**Chapter 10: Hypothesis Testing** Examples on large sample tests

		p-values Small sample tests Examples on testing variances Examples on probability of type I and type II error
Asynchronously recorded video	**May 5**	**Chapter 10: Hypothesis Testing** More examples on large and small samples Relationships between HT & CI HT concerning variances
Wednesday	**May 5**	**7th Homework Due**
Final Exam:	**May 11**	**Exam will start at 7:00 pm**