ECON 502
Economic Statistics
Section M1(64708), TR 9:30 am-10:50 am
Section M2(64709), TR 11:00 am -12:20 pm
Department of Economics • UIUC
Course Syllabus Fall 2022

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

Instructor: Ali Toossi
Office: 205C DKH
Phone: 217-333-6777
E-mail: toossi@illinois.edu
Office hours: MW 2:30 pm-3:30 pm. I can consider other times if these dates/times is not good for you.
Attendance in the in-person lectures is mandatory. If you are not able to attend, you must contact me for permission not to attend.

Assistant Instructor (AI):

This course has two assistant instructors (AI). The AI's will hold a review session on Fridays. In these sessions, the AI will review the material covered in class, go over more examples, and answer your questions. The attendance in the review sessions is mandatory. If for any reason you are not able to attend, you must contact the AI and get her permission not to attend. The assistant instructors will also hold daily office hours. You can also request individual appointments as needed.

Cihang Wang (section M1):
Office: 110 DKH
E-mail: ls12@illinois.edu
Daily Office hours: MW 1:00 - 2:00 pm, TR 4:00 pm - 5:00 pm You can also set up individual appointments.
Weekly Review Session: Friday 2:00 pm- 3:20 pm, 386 Armory

Lovepreet Singh (section M2):
Office: 110 DKH
E-mail: cwang153@illinois.edu
Daily Office hours: MTWR 2:00 pm - 3:00 pm. You can also set up individual appointments.
Weekly Review Session: Friday 3:30 pm- 4:50 pm, 386 Armory

*The first meeting of Friday sessions will be on **Friday August 26**.*

Canvas 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://canvas.illinois.edu/ I also have created a discussion board on Canvas. You can post your questions there and either me, Cihang or Lovepreet will 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 homeworks). Each assignment consists of some problems and an Excel or R project. There will also be some *optional* problems assigned from the textbook. 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. I will also distribute a printed copy in class.
The assignments must be completed neatly, professionally, and legibly. Solution to the assignments should contain the following information on the **right-hand corner** of the first page: your name, assignment number, and the date.

For each assignment a deadline will be announced. Any solutions submitted after the deadline will not be graded.
The way you submit your solution will be described in the assignment. Your solution to the assignments will be either collected at the **beginning** of the lecture at the due date or you must put them in the mailbox of your AI. The mailboxes are located in the MSPE office at 205 DKH.

Exams: The class will have two *midterm exams* and *a final exam*. The midterm exams are for one hour 20 minutes (during the class time) and final exam three hours.

The dates of the exams are as follows:

Midterm 1: ~~Thursday, ***September 30***~~, **Tuesday October 5**
Midterm 2: ~~Thursday, ***November 4***~~, **Thursday November 11**
Final exam:
Regular: Monday ***December 13***, 8:00-11:00 am (Combined exam)
Conflict: Wednesday ***December 15***, 8:00-11:00 am

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

According to the Student Code, `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.' Please know that it is my responsibility as an instructor to uphold the academic integrity policy of the University, which can be found here: https://studentcode.illinois.edu/article1/part4/1-401/

Academic dishonesty may result in a failing grade. Every student is expected to review and abide by the Academic Integrity Policies. It is your responsibility to read this policy to avoid any misunderstanding. Do not hesitate to ask the instructor(s) if you are ever in doubt about what constitutes plagiarism, cheating, or any other breach of academic integrity. **Read the full Student Code at** https://studentcode.illinois.edu/

Students with Disabilities

To obtain disability-related academic adjustments and/or auxiliary aids, students with disabilities must contact the course instructor and the Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES you may visit 1207 S. Oak St., Champaign, call 333-4603 (V/TTY), or e-mail a message to disability@illinois.edu. DRES Website: www.disability.illinois.edu/

Community of Care

As members of the Illinois community, we each have a responsibility to express care and concern for one another. If you come across a classmate whose behavior concerns you, whether in regards to their well-being or yours, we encourage you to refer this behavior to the Student Assistance Center (217-333-0050 or http://odos.illinois.edu/community-of-care/referral/). Based on your report, the staff in the Student Assistance Center reaches out to students to make sure they have the support they need to be healthy and

safe. Further, we understand the impact that struggles with mental health can have on your experience at Illinois. Significant stress, strained relationships, anxiety, excessive worry, alcohol/drug problems, a loss of motivation, or problems with eating and/or sleeping can all interfere with optimal academic performance. We encourage all students to reach out to talk with someone, and we want to make sure you are aware that you can access mental health support at the Counseling Center (https://counselingcenter.illinois.edu/) or McKinley Health Center (https://mckinley.illinois.edu/).
For mental health emergencies, you can call 911 or walk into the Counseling Center, no appointment needed.

Disruptive Behavior
Behavior that persistently or grossly interferes with classroom activities is considered disruptive behavior and may be subject to disciplinary action. Such behavior inhibits other students' ability to learn and an instructor's ability to teach. A student responsible for disruptive behavior may be required to leave class pending discussion and resolution of the problem and may be reported to the Office for Student Conflict Resolution for disciplinary action.

Emergency Response Recommendations

Emergency response recommendations can be found at the following website: http://police.illinois.edu/emergency-preparedness/. I encourage you to review this website and the campus building floor plans website within the first 10 days of class. http://police.illinois.edu/emergency-preparedness/building-emergency-actionplans/.

Religious Observances
The Religious Observance Accommodation Request form is available at https://odos.illinois.edu/community-of-care/resources/students/religious-observances/. Submit the form to the instructor and to the Office of the Dean of Students (helpdean@illinois.edu) by the end of the second week of the course; in the case of exams or assignments scheduled after this period, students should submit the form to the instructor and to the Office of the Dean of Students as soon as possible.

Family Educational Rights and Privacy Act (FERPA)

Any student who has suppressed their directory information pursuant to Family Educational Rights and Privacy Act (FERPA) should self- identify to the instructor to ensure protection of the privacy of their attendance in this course. See http://registrar.illinois.edu/ferpa for more information on FERPA. Student information and records will not be released to anyone other than the student unless the student has provided written approval or as required by law.

Sexual Misconduct Reporting Obligation

The University of Illinois is committed to combating sexual misconduct. Faculty and staff members are required to report any instances of sexual misconduct to the University's Title IX and Disability Office. In turn, an individual with the Title IX and Disability Office will provide information about rights and options, including accommodations, support services, the campus disciplinary process, and law enforcement options. A list of the designated

University employees who, as counselors, confidential advisors, and medical professionals, do not have this reporting responsibility and can maintain confidentiality, can be found here: http://www.wecare.illinois.edu/resources/students/#confidential.
Other information about resources and reporting is available here: http://wecare.illinois.edu/.

Student Support

The Counseling Center is committed to providing a range of services intended to help students develop improved coping skills in order to address emotional, interpersonal, and academic concerns. Please visit their website to find valuable resources and services: https://counselingcenter.illinois.edu/.

Counseling Center Information: 217-333-3704
Location: Room 206, Student Services Building (610 East John Street, Champaign IL)

McKinley Mental Health Information: 217-333-2705
Location: 3rd Floor McKinley Health Center 1109 South Lincoln, Urbana, IL

Emergency Dean: The Emergency Dean may be reached at (217) 333-0050 and supports students who are experiencing an emergency situation after 5 pm, in which an immediate University response is needed and which cannot wait until the next business day. The Emergency Dean is not a substitute for trained emergency personnel such as 911, Police or Fire. If you are experiencing a life threatening emergency, call 911. Please review the Emergency Dean procedures: http://odos.illinois.edu/emergency/

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

Lecture	Date	Topics Covered
1	August 23	**Chapter 1: What is statistics?** Descriptive & Inferential Statistics Population or Process, Sample Strategies for collecting data
2	August 25	**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 Quantitative: discrete vs Continuous **Descriptive statistics:** Quantiles, Mean (Arithmetic, Geometric), trimmed mean
3	August 30	**Chapter 1: What is statistics?** (*Continued*) **Descriptive statistics:** Median, mode, Variance, CV, MAD, Empirical Rules, Skewness, Kurtosis, JB test for normality

4	September 1	**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
Tuesday	**Sept. 6**	**First Homework Due**
5	September 6	**Chapter 2: Probability** (*Continued*) 3- axiomatic approach, Using axiomatic approach to derive some results Assigning probability of event: Sample point method Tools for counting: multiplication rule,
6	September 8	**Chapter 2: Probability** (*Continued*) permutation, combination Binomial & multinomial coefficients examples on counting additive law of probability Conditional probability
7	September 13	**Chapter 2: Probability** (*Continued*) Multiplicative law of probability Independence & conditional independence of events Calculating probability of event: event composition method Using table to solve problems The law of total probability
8	September 15	**Chapter 2: Probability** (*Continued*) & Bayes' rule **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
Recorded Video (1)	**September 16**	**Chapter 2: Probability (*Continued*)** **More examples on Bay's rule** **Simple random sampling** **Random Variable (RV): Definition, Discrete & continuous RV**
Saturday	**Sept. 18**	**Second Homework Due**

9	September 20	**Chapter 3: Discrete random variables (continued)** Examples on expected value and variance Bernoulli experiment & related distributions Bernoulli Distribution Binomial Distribution: Definition and formula Binomial Distribution: as sum of Bernoulli random variables, Mean, variance
Recorded Video (2)	**September 21**	**Chapter 3: Discrete PDF (*Continued*)** **More examples on Binomial** **Hypergeometric** **Geometric** **Negative binomial**
10	September 22	**Chapter 3: Discrete random variables (continued)** Examples on Binomial Distribution Poisson process & Poisson distribution
11	September 27	**Chapter 3: Discrete random variables (continued)** Examples on Poisson Distribution Moments around origin and about the mean Moment generating functions
12	September 29	**Chapter 3: Discrete random variables (continued)** Tchebysheff's Theorem **Chapter4: Continuous random variables** Cumulative Distribution function (CDF) Discrete Y: CDF ➔STEP function (right Continuous)
Sunday	**October 3rd**	**Third Homework Due**
Monday	**7:00 pm October 3th**	**Zoom: Exam 1 Review session**
Midterm 1	**Tuesday October 4**	**During class time**
13	October 6	**Chapter4: (continued)** Continuous Y: CDF ➔Continuous function Continuous Y: Probability Density Function Relation between CDF & PDF Example on PDF & CDF

		Expected value & Variance of Continuous RV The uniform PD
recorded video (3)	**October 6**	**Extra examples on continuous distributions + uniform & Normal distributions**
Friday Review Session	**October 7**	**Normal PD + Examples on Normal:** (7^{th}, 4.58, page 181) + (7^{th}, 4.63, page 182)
14	October 11	**Chapter4: (continued)** The Gamma PD Gamma Special cases: Chi-square, Exponential Memoryless property of Exponential Examples on exponential
recorded video (4)	**October 11**	**Chapter4: Relationship between Gamma & Poisson** **Relationship between Exponential & Poisson** **Hazard function**
15	October 13	**Chapter4: (continued)** Beta Distribution 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
Tuesday	**October 18**	**4^{th} Homework Due**
16	October 18	**Chapter 5: Bivariate PD (discrete)** Example on bivariate discrete distributions Covariance & Correlation expected value and variance of a linear function

recorded video (5)	**October 18**	**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	October 20	**Chapter 5: Bivariate PD (discrete)** Expected value & variance of sample mean **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
recorded video (6)	**October 20**	***Chapter 5: Bivariate probability distributions (continuous)*** **Examples on Bivariate continuous variables and conditional expectations**
18	October 25	**Chapter 5: Bivariate probability distributions (continuous)** Conditional expectations Example on conditional expectation Law of iterated expectations 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	October 27	**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
	October 27	**More Examples on chapter 6**

recorded video (7)		
20	November 1	**Chapter 6: Functions of random variables (sections 6.1-6.5)** Finding distribution of sample mean using method of MGF **Chapter 7: Sampling distribution & the CLT** Definitions of distributions t-student & F Sampling distribution of sample mean, sample variance Normal; approximation of Binomial (Watch video 8)
recorded video (8)	**November 1**	**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
21	November 3	**CHAPTER 7:** Example of normal approximation of binomial Central limit theorem **Chapters 8 & 9** **8.2**: properties of point estimators: The bias and mean square error **Problem 9.8 (page 448):** Cramer-Rao Theorem: Find the minimum variance of unbiased estimators

		9.3: Consistent estimators
recorded video (9)	**November 3**	**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
Sunday	**November 6**	**Fifth Homework Due**
22	November 8	**Chapter 9:** **9.4:** Sufficiency Likelihood function and factorization criterion **9.6:** Estimation method: moments Examples on Method of moments **9.7:** Estimation method: maximum likelihood Examples on Method of maximum likelihood
Recorded Video (10)	**November 8**	**Chapter 9:** More explanation & example on sufficiency
Extra Material	**The topics in the next column will not be on exam. Students interested in these topics can watch video 11 & 11'**	Distributions of Exponential Forms (DEF) DEF & sufficient statistics DEF & Minimum Variance Unbiased Estimators (MVUE)
Recorded Video (11) & (11')	**November 8**	**Chapter 9:** Examples on Factorization criterion Examples on "distribution of exponential forms", "application of Lehman-Scheffe theorem" & "method of moments"
Exam 2	**Thursday November 10**	**During class time**
23	November 15	**Chapter 8 revisited** Example on MLE for uniform distribution **8.5:** Confidence intervals (CI) **8.6:** large sample CI for the mean and proportion **8.8:** Small sample confidence interval for: the mean & difference of means **8.9:** Confidence interval for the variance

Recorded Video (12)	**November 15**	**Chapter 9:** **Example on MLE** **Chapter 8 (revisited):** **Examples on large sample confidence intervals**
24	November 17	Example on CI for population 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 Example on Power Function
Recorded Video (13)	**November 17**	**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*
Recorded Video (14)	**November 17**	**Chapter 10: Hypothesis Testing** *Simple vs composite hypothesis Neyman Pearson Lemma* *Examples on N-P Lemma* Uniformly Most Powerful Tests
recorded video (15)	**November 17**	**Chapter 10: Hypothesis Testing** Example on Power Function *Likelihood ratio tests with an example*
Saturday	**November 19**	**Sixth Homework Due**
	Nov 19 – Nov 27	**Fall Break**
25	November 29	**Chapter 10: Hypothesis Testing** *Simple vs composite hypothesis* *Neyman Pearson Lemma* *Examples on N-P Lemma* Uniformly Most Powerful Tests Example on Neyman-Pearson Lemma Examples on large sample tests p-values
recorded video (16)	**November 29**	**Chapter 10: Hypothesis Testing** *Example on Likelihood ratio tests* The recipe for doing large sample tests
26	December 1	**Chapter 10: Hypothesis Testing** Examples on p-values Small sample tests Testing hypothesis about population

		variance *Testing hypothesis about variances of two populations*
recorded video (17)	**December 1**	**Chapter 10: Hypothesis Testing** More examples on large and small samples Relationships between HT & CI HT concerning variances
27	December 6	More examples on hypothesis testing
Wednesday	**Dec. 7**	**7th Homework Due**
	December 8	Reading Day: No Class
Thursday	**4:00 pm December 8**	**Zoom: Final Exam Review session**
Final Exam:	***Friday, December 9***	**Exam will start at 1:30 pm**