ARE 210: Department of Economics Fall 2024
UC Berkeley ARE

Lectures: MW 10 A.M. – 11:40 A.M.
Location 201 Giannini
Section: Every other week TBA
Instructor: Aprajit Mahajan (aprajit@berkeley.edu)
Office Hours: (Tentative) M 2 P.M. – 4 P.M. and by appointment.
Course Web: https://bcourses.berkeley.edu/courses/1537855
Final: **8-11AM, Monday December 16** (Group 1)
Document Last Updated: October 9, 2024

Overview

The main text book is Casella and Berger (2001) (CB) and we will cover the material in Chapters 1-10 although at a level somewhat higher than presented in the text. I will make available a set of lecture notes that will form the primary reading material for the course. In addition, I will provide a set of Jupyter notebooks (in Python) that will illustrate some of key concepts in the notes (though there is no programming component to the class itself).

There are several other books that discuss the material covered and which one is optimal for a student will depend on her/his background. Examples of such books are (in approximate order of difficulty) Hogg and Craig (1995), DeGroot and Schervish (2001), Bickel and Doksum (2000), Severini (2012), Gallant (1997), Bierens (2004), Florens et al. (2007), Lehmann and Casella (2003), Shao (2003), Keener (2010), Rao (2002), White (2000), Lehmann and Romano (2022), van der Vaart (1998), Çinlar (2011), Schervish (1996) and Billingsley (1995). Bruce Hansen has an excellent newly published text book (Hansen, 2022) that covers the material in this course and Efron and Hastie (2016) provides a nice accessible overview of a good deal of the statistical material we will cover in this course.

Problem Sets: The material covered in the course cannot be learned without solving a lot of problems and there will be 5-7 problem sets. I cannot overemphasize the importance of working through the problem sets. There is a strong correlation between working hard on the problem sets and doing well on the course exams. The problem sets will not be graded but I will provide detailed solutions and spend some class time going over them.

Grading: Your grade in the course will be based on your performance on a final exam (65%) and a midterm (35%). The midterm will be in-class on **Monday, October 14**. The final will be as scheduled by the registrar on **8-11AM, Monday December 16** (Group 1).[1]

Student Accomodations

We will follow the guidelines set out by the university that are available here.[2] These guidelines deal with a range of issues – in particular, with respect to (a) accommodation of religious creed, (b) accommodation for pregnancy and parenting, (c) conflicts between extracurricular and academic environments, (d) absence due to illness and (e) accommodation for disability.

[1] See the registrar's final schedule at https://tinyl.io/6oPZ.

[2] http://teaching.berkeley.edu/academic-calendar-and-student-accommodations-campus-policies-and-guidelines#anchor4

Covid

We are all expected to follow the university's covid policies.[3] The guidelines include requirements for accessing campus and information about what happens if someone tests positive for COVID-19. I will follow the guidance for instructors. Please let me know if you need anything, particularly if you will be missing class due to illness. I will use record lectures (or at the very least, my Ipad screen) for students unable to attend lecture.

Statement on Academic Integrity

Any test, paper or report submitted by you and that bears your name is presumed to be your own original work that has not previously been submitted for credit in another course unless you obtain prior written approval to do so from your instructor.

If you are not clear about the expectations for completing an assignment or taking a test or examination, be sure to seek clarification from your instructor beforehand.

Academic dishonesty and misconduct will be handled according to university regulations with no exceptions. Please see the relevant sections on academic integrity at UCB Official Notices.[4]

Cheating: A good lifetime strategy is always to act in such a way that no one would ever imagine that you would even consider cheating. Anyone caught cheating on a quiz or exam in this course will receive a failing grade in the course and will also be reported to the University Center for Student Conduct. In order to guarantee that you are not suspected of cheating, please keep your eyes on your own materials and do not converse with others during the quizzes and exams.

Plagiarism: To copy text or ideas from another source without appropriate reference is plagiarism and will result in a failing grade for your assignment and usually further disciplinary action. For additional information on plagiarism and how to avoid it, see, for example here[5] and here.[6]

In all of your assignments, including your homework or briefs, you may use words or ideas written by other individuals in publications, web sites, or other sources, but only with proper attribution. "Proper attribution" means that you have fully identified the original source and extent of your use of the words or ideas of others that you reproduce in your work for this course, usually in the form of a footnote or parenthesis.

As a general rule, if you are citing from a published source or from a web site and the quotation is short (up to a sentence or two) place it in quotation marks; if you employ a longer passage from a publication or web site, please indent it and use single spacing. In both cases, be sure to cite the original source in a footnote or in parentheses.

Academic Integrity and Ethics: Cheating on exams and plagiarism are two common examples of dishonest, unethical behavior. Honesty and integrity are of great importance in all facets of life. They help to build a sense of self-confidence, and are key to building trust within relationships, whether personal or professional. There is no tolerance for dishonesty in the academic world, for it undermines what we are dedicated to doing – furthering knowledge for the benefit of humanity. Your experience as a student at UC Berkeley is hopefully fueled by passion for learning and replete with fulfilling activities. And we also appreciate that being a student can be stressful. There may be times when there is temptation to engage

[3] https://coronavirus.berkeley.edu/
[4] https://teaching.berkeley.edu/resources/design/academic-integrity
[5] https://gsi.berkeley.edu/gsi-guide-contents/academic-misconduct-intro/plagiarism/
[6] http://gsi.berkeley.edu/teachingguide/misconduct/prevent-plag.html

in some kind of cheating in order to improve a grade or otherwise advance your career. This could be as blatant as having someone else sit for you in an exam, or submitting a written assignment that has been copied from another source. And it could be as subtle as glancing at a fellow student's exam when you are unsure of an answer to a question and are looking for some confirmation. One might do any of these things and potentially not get caught. However, if you cheat, no matter how much you may have learned in this class, you have failed to learn perhaps the most important lesson of all.

Out of Class Collaboration

You are allowed to work together in groups for the problem sets, but each student must turn in an individual problem set with their own solutions. Please indicate on the solution the names of the other students, if any, who worked with you on the problem set. It is not a violation of this policy to submit essentially the same answer on a problem set as another student, but is a violation of this policy to submit a close to exact or exact copy.

Regrade Requests

If there was an unambiguous mistake in the grading of your exam, you may request a regrade but note that your **entire** problem set (or exam) will be regraded. You should be aware that your grade may go up or down on the regrade request.

Requests for regrades based on attempts to get more partial credit will be automatically denied. Requests for regrades based on a desire for a better grade and not based upon a mistake in the grading will be automatically denied. Requests for regrades based on interpreting what you wrote or what you meant to say will be automatically denied.

All regrade requests should be in writing, stating exactly what was misgraded, and should be submitted to the grader within one week of the date on which the material was returned to you. Any regrade request submitted after one week of when the material was returned to you will be automatically denied.

Course Management

- We will make extensive use of the bcourses web-site[7] throughout the quarter. Lecture handouts, problem sets and solutions will all be posted on coursework. In addition, important announcements about office hours, times and locations will also be made on coursework. Please make sure to check the site regularly.

- To help us deal efficiently with the potentially large volume of course-related correspondence, please include "ARE210" in the subject heading (e.g. Subject: ARE210 problem set question) when emailing. There is no guarantee that emails that do not contain ARE210 in the subject line will be read.

Course Outline

1. **Probability I**: Measurable Spaces, Probability Measures, Random Variables, Random Vectors, Conditional Probability and Independence, Bayes Theorem, Distributions, Transformations.
   Readings: Ch. 1 and 2 of CB, Ch.1 and 2 of Çinlar (2011)

[7] https://bcourses.berkeley.edu/courses/1537855

2. **Probability II**: Expectations, Moments, Laplace Transforms, Characteristic Functions, Useful Inequalities (Markov, Cauchy-Schwarz, Jensen), Joint Distributions, Covariance, Correlations, Conditional Distributions, Conditional Expectations, Useful Distributions.
   Readings: Ch. 2, 3 and 4 of CB, Ch.1 and 2 of Çinlar (2011), Ch 2-5 of Hansen (2022).

3. **Basic Asymptotic Theory**: Almost Sure Convergence, Convergence in probability, Convergence in Distribution, Mean Square Convergence, Convergence of Random Vectors, Laws of Large Numbers, The Classical Central Limit Theorem, Continuous Mapping Theorem, Slutsky's Lemma, Delta Method.
   Readings: Ch. 5 of CB, Chs. 2 and 3 of van der Vaart (1998).

4. **Identification in Economic Models**: The Identified Set, Point Identification, Identification in Parametric Models, Identification in Economic Models. Examples: Linear Regression, Non-parametric Regression, Instrumental Variable Models, Binary Choice Models, Selection Models, The Roy Model, Censored Models, Missing Outcome Data, Exponential Families.
   Readings: Matzkin (1994), Breiman (2001), Matzkin (2007), Manski (2008), Lewbel (2017), Heckman and Pinto (2022). Elie Tamer's interview with Chuck Manski (Tamer, 2018) is very useful as well and a good companion for the first year sequence.

5. **Introduction to Estimation Methods**: The Analogy Principle as a general strategy for formulating estimators. Three popular classes of estimators: (a) Maximum Likelihood (b) M-Estimators and (c) Minimum Distance Estimators (with (Generalized) Method of Moments as the leading example). Finite Sample Properties of Estimators. Sufficiency, Ancillarity, Completeness, Loss Functions, Risk Functions, UMVUE, Cramer-Rao Lower Bound, Examples: Exponential Families, Linear Regression, Multiple Equation Models (SUR, FIML), Binary Choice Models, Linear IV Models, (Non-Linear) Least Squares.
   Readings:Ch. 7 of CB, Chs. 3 and 4 of Keener (2010), Ch. 6, 10 and 11 of Hansen (2022), Manski (1994).

6. **Large Sample Properties of Estimators**: Consistency, Asymptotic Normality and Consistent variance estimation for Maximum Likelihood, M- and Minimum Distance estimators. Examples: (Heteroscedasticity Robust) Linear Regression, Non-Linear Least Squares, Binary Choice. Hodges' Example, Asymptotic Efficiency of MLE.
   Readings: Ch.7 of CB, Chapter 3 of Wooldridge (2010), Chapter 7 of Hayashi (2000), Newey and McFadden (1994), Stigler (2007).

7. **Hypothesis Testing**: 0-1 Loss Function, Type I, II errors, Power, Size, Significance Level, p-values, Critical Regions, Distance Function Principle, Neyman-Pearson Lemma, UMP and UMPU tests. Bahadur-Savage Example, T-tests, F-Tests, Chi-Squared Tests, Monotone Likelihood Ratio Families, Trinity of Tests (Likelihood Ratio, Wald, Lagrange Multiplier), Asymptotic equivalence of the Trinity, Hypothesis Testing in Large Samples, Consistency of Tests.
   Readings: Ch.8 of CB and Ch.7 of Hayashi (2000), Chapters 3, 4 of Lehmann and Romano (2022), Benjamin et al. (2017).

8. **Constructing Confidence Regions**: Confidence Region, Confidence Level, Confidence Coefficient, Duality between Confidence Regions and Hypothesis Tests, Pivotal and Asymptotically Pivotal Quantities, Uniformly Most Accurate (UMA) Confidence Regions and Uniformly Most Accurate Unbiased

(UMAU) Confidence Regions, Asymptotically valid Confidence Regions. Pratt's Theorem.
Readings: Ch.9 of CB.

9. **Resampling Methods**: The Bootstrap, Non-parametric Bootstrap, Percentile Intervals, Percentile-t Equal Tailed Intervals, Asymptotic Expansions, Higher-Order Refinements, Bootstrap methods for linear regression. Sub-sampling. Randomization (Permutation) Inference.
Readings: Efron and Tibshirani (1994), Horowitz (2001), Politis et al. (1999), Ch.18 of Lehmann and Romano (2022).

References

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