University of California, Davis
Institute of Transportation Studies

TTP 289A-001 FQ 2023 (CRN 52847)
Discrete Choice Modeling

Fall 2023 - M/W 4:10-6:00 pm – 3212/3211 Teaching & Learning Complex (TLC)
Instruction period: September 27 – December 8, 2023*

Initial Course Syllabus (Version: September 7, 2023*)
(*Syllabus is subject to additional updates, so the version dates are noted.)

IMPORTANT: Please regularly check your e-mail prior to the start of classes

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Instructors

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Format/Session Information

- Format: 4 units
- Dates: Classes meet September 27-December 6, 2023.
- Time/Day: Monday/Wednesday 4:10-6 pm (lecture/hands on)
- Finals Week: December 11-15, 2023 [Final session TBA]
- Location: 3212/3211 Teaching & Learning Complex (TLC)
- Grading: Letter graded

Brief Clarification on Course Timing and Scheduling

This is the *introductory* TTP/EGG course in **Discrete Choice Modeling**, which is generally offered every year. This is *not* to be confused with **Advanced Discrete Choice Modeling (ADCM)**, which is a follow-on course that is offered *every other year*. For example, last year DCM was offered in the Winter (WQ 2023), but ADCM was not offered. *This year's* offering of DCM (this course) is offered now (Fall 2023): the Advanced DCM class is scheduled for *next quarter* (WQ 2024). Students taking this course will therefore be able to continue with ADCM next quarter. (And, we expect the WQ 2024 ADCM to have a *mix* of students from this year and last year.) Note that, following this pattern, the next ADCM course *would not be offered again until WQ 2026*! Students should consider this for

their course planning. For example, it would be possible to postpone taking some other Fall TTP course until next year (to make room for DCM), if a student wants to take the DCM-ADCM sequence this year. If you have questions, please discuss this with one of us, or especially your major professor or other advisors.

Prerequisites

- Students should have taken a calculus-level introduction to probability and statistics, but importantly, **background and experience with standard statistical analysis of data, including linear regression is required and expected**.
- Note: The statistics/linear regression requirement is something to be carefully considered. (How many prior courses with this material have you taken? How long has it been since you last took this type of course? What actual experience do you have in using this, beyond coursework?) Please consult with an instructor if you have concerns or questions.
- Prior to the first day of class, we will circulate additional materials to support a more structured review of background material.
- Other background related to theory of consumer decision-making such as microeconomics would also be helpful.

Course Description

- Many aspects of policy, management, and engineering require an understanding of how humans make decisions, and why. These decisions frequently involve **discrete choices**, e.g., which product to purchase, which travel mode (drive alone, carpool, bus, train) to use for a particular trip, what vehicle to purchase, whether to participate in the workforce, etc.
- **Discrete choice modeling** has become an essential skill for researchers who need to understand and model consumer behavior and market demand for products and services in a wide variety of fields, including travel demand forecasting, economics, marketing, and energy policy.
- The course introduces both theory and practical aspects of modeling individual choice behavior, including data requirements, model formulation, statistical estimation and testing, interpretation, and prediction/forecasting for applications in policy evaluation, service and product design, etc.
- Students will gain hands-on experience, performing exercises using software and data sets. Hands-on work will include both homework assignments and a project.

Course Objectives

- Students will gain an understanding of the behavioral and statistical foundations of discrete choice models required for formulating and estimating their own models in their respective fields.

- Students will learn about the various families and types of discrete choice models, and when they would be applied in varying applications.
- Students will gain experience in formulating, estimating, testing, and interpreting discrete choice models using empirical data sets. The course will use the Apollo choice modeling R package.

Texts

- There is no official text for the course. Students will be provided with a variety of handouts and pdfs of readings during the course. However, students will find the following references to be useful:
    - Ben-Akiva, Moshe and Steven R. Lerman (1985) *Discrete Choice Analysis: Theory and Application to Travel Deman*d. Cambridge, Mass.: MIT Press.
    - Train, Kenneth E. (2009) *Discrete choice methods with simulation*. Cambridge University Press.
    - Ortuzar, Juan de Dios and Luis G. Willumsen (2011) *Modeling Transport. Chichester: Wiley*.

Course Grading

- Grading will be based on the following on a mixture of individual and group modeling assignments, and quizzes:

Class participation	10%
Quizzes	15%
Assignment 1	15%
Assignment 2	20%
Assignment 3a (group)	20%
Assignment 3b (individual)	20%

- A total of four quizzes will be administered throughout the quarter. You can choose the best three out of four quizzes (each quiz will count for 5% towards the final grade).
- There will be three major assignments. Each of the first two (individual) assignments will count for 20% of the grade. They will involve performing modeling and analysis using datasets provided by the instructor. The third assignment is divided into two parts. In part *a*, students will work in pairs to develop a research topic that requires problem formulation, identification of data set(s), and a modeling strategy. Students will receive feedback and advice. In part *b*, students are responsible for executing the strategy and producing a report on an individual basis. There is the possibility that we may have students present their results.
    - NOTE: A major objective of mine when teaching this type of course is for students to internalize a more general understanding of how discrete choice modeling fits

into the larger picture of performing meaningful research with a well-defined purpose and objectives. In many cases, students may already be working on funded research projects with an advisor or for other ITS principal investigators. To the degree that it is possible for students to identify project topics that overlap with their current research efforts or interests, we would like to do so.

- Students may confer and provide support to one another on Assignments 1 and 2. However, students must produce the final product on their own as described below under the honor code review.
- Groups are limited to pairs, and groups of three members are generally not allowed (except under very special circumstances, considered on a case-by-case basis). Larger groups face more complicated logistics, requires appropriate adjustment to the scope of work to create fairness across groups, generates more issues with free-ridership, and increases the risk of reduced understanding of the material and pedagogical value of the assignments.

Honor Code

- Plagiarism is defined by Webster's Dictionary (http://www.merriam-webster.com/dictionary/plagiarism) as "the act of using another person's words or ideas without giving credit to that person." If caught plagiarizing, you will be dealt with according to the UC Davis Code of Academic Conduct (http://sja.ucdavis.edu/files/cac.pdf).
- You may discuss the assignment with other students in the class. However, each student or team must submit her/his/their own homework solutions, written in her/ his/their own words. The content of any assignment turned in should be only that of the person (people) whose name(s) is (are) on the assignment. Copying or borrowing from another person's solution is a violation of the UC Davis Code of Academic Conduct, and will be dealt with accordingly. Similarly, copying or borrowing from the lecture notes or from any other source, without proper attribution is a violation.
- Unauthorized use of any previous course materials such as graded homework assignments, other than that explicitly allowed by me or my delegate, is prohibited in this course. Therefore, unauthorized use of such materials is a violation of the UC Davis Academic Honor Code, and will be dealt with accordingly.
- When in doubt, don't assume or rationalize -- ask! The instructor is here to answer your questions.
- For any questions involving these or any other Code of Academic Conduct issues, please consult me or visit http://sja.ucdavis.edu/

UC Davis Student Disability Center

- UC Davis is committed to educational equity in the academic setting, and in serving a diverse student body. All students who are interested in learning about how disabilities are accommodated can visit the Student Disability Center (SDC). If you are a student who requires academic accommodations, please contact the SDC directly at sdc@ucdavis.edu or 530-752-3184. If you receive an SDC Letter of Accommodation, submit it to your instructor for each course as soon as possible, at least within the first two weeks of a course.

Other Rights and Responsibilities

- All participants in the course, instructor and students, are expected to follow the UC Davis Principles of Community, which includes affirmation of the right of freedom of expression, and rejection of discrimination. The right to express points-of-view without fear of retaliation or censorship is a cornerstone of academic freedom. A diversity of opinions with respectful disagreement and informed debate enriches learning. However, in this course, any expression or disagreement should adhere to the obligations we have toward each other to build and maintain a climate of mutual respect and caring.
- All material in the course that is not otherwise subject to copyright is the copyright of the course instructor and should be considered the instructor's intellectual property.

Course Outline

The following content will be covered in the course. Some changes in the course outline and lecture schedule might be introduced to make adjustment for this particular group's background and preparation (see, in particular, the informal prerequisites of the class), specific interests in particular topics, etc. A more detailed schedule grid will be provided as we get closer to the start of the quarter.

- Introduction:
    - o Why probabilistic models
    - o RP and SP data
    - o Applications of disaggregate discrete choice models
- Review of prob. and statistics fundamentals
    - o Joint, marginal, and conditional distributions for discrete and continuous RVs
    - ○ Joint, marginal, and conditional distributions for discrete and continuous RVs

    Maximum likelihood estimation
    - o Desirable properties of estimators
- Review of linear regression models
    - o Ordinary least squares estimation
    - o Interpretation of model results

- Theories of individual choice behavior
    - o Non-compensatory models
    - o Constant and strict utility theory; IIA
    - o Random utility theory
- Binary choice models
    - o Derivation of linear, logit, and probit models
    - o Comparison of binary logit model to logistic regression
    - o Prototypical model specification
    - o Maximum likelihood estimation
    - o Diagnostic tests (Quasi-t, $\chi 2$, $\rho 2$ or pseudo-R2, adjusted $\rho 2$, % correctly classified, success table)
- Multinomial choice models
    - o Background
    - o Properties of the extreme value distribution
    - o Derivation of general and multinomial logit choice probabilities
    - o MNL: Testing for IIA
    - o MNL: Elasticities (disaggregate versus aggregate)
    - o Maximum likelihood estimation of multinomial logit
    - o Taste variation (market segmentation, bases for segmentation, testing for significant differences between segments)
- Other discrete choice models
    - o Multinomial probit
    - o Nested logit
    - o Generalized extreme value
    - o Introduction to ordinal response models, latent-class models, and mixed logit
- Application issues
    - o Causality and interpretation of results
    - o Sampling
    - o Choice-based sampling
    - o Applications to new transportation modes and emerging mobility services (shared mobility, e-scooters, AVs, etc.)